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ORIGINAL ARTICLES.

I.—On the Discovery of *Cyclosphæroma* in the Purbeck Beds of Aylesbury.

By Henry Woodward, LL.D., F.R.S., F.G.S., etc.

(PLATE XIV.)

IN December, 1890, I had the good fortune to describe a new Sphæromid discovered by Mr. Thomas Jesson, B.A., F.G.S., in the Great Oolite of Northampton, which I named *Cyclosphæroma trilobatum* (see Geol. Mag., 1890, Dec. III, Vol. VII, pp. 529–533, Pl. XV). This specimen, which is redrawn on the accompanying Pl. XIV (Fig. 1), is remarkable for its rounded outline, which induced me to apply to it the name *Cyclosphæroma*.

Great was my joy when, in March last, I received from my friend Mr. E. J. Garwood, M.A., F.G.S., another Jurassic Isopod, of which both the intaglio and the relievo had been obtained by him in the Purbeck beds near Aylesbury. This remarkably beautiful Crustacean proves to be a more perfectly preserved example of the same Sphæromid which I had described in 1890, from the Great Oolite of Northampton, and it needs but to compare Figs. 1 and 2 upon our Plate to perceive that in Fig. 1 the thoracic segments are much compressed together posteriorly, and that the hinder part of the telson is wanting; otherwise the resemblance between it and the newly-found and much more perfect example from the Purbeck beds of Aylesbury (Pl. XIV, Fig. 2) is unmistakable.

A reference to the diagnosis of the genus (as given in Geol. Mag., 1890, p. 530) will show that it must now be amended in consequence of the discovery of the more complete specimen by Mr. Garwood.

CYCLOSPHÆROMA, H. Woodw., 1890 (*emended* 1898).

General outline of body longer than broad in the proportion of 5 to 3. Cephalon trilobate one-fifth the length of body, rounded and tumid, surface granulated; eyes moderately large, cornea vitreous, but facets of eye distinctly visible with a hand-lens; thoracic segments seven in number, rather broader than the head-shield or telson, with square margins, epimeral portion of segments distinctly defined by a lateral line; first thoracic segment coalesced with cephalon and encircling the eyes; segments of

abdomen coalesced together; telson distinct, triangular in outline, with a strong median ridge, equal in length to the seven thoracic segments; surface of telson more sparsely ornamented, granulations coarser, with three larger tubercles marking a small triangular area at the proximal end of the median ridge. Traces of the epimera of two coalesced abdominal segments are seen near the union with the telson.

Although no appendages are preserved in the fossil, the deep emargination on the sides of the telson, at its union with the coalesced segments of the abdomen, indicates with certainty the exact point of articulation of the last pair of pleopoda or uropoda, as certainly as if they had been preserved in the fossil, and as actually shown in place in the four recent examples figured on our Plate XIV (Figs. 3, 4, 5, and 6). We give an ideal restoration of these appendages below:—

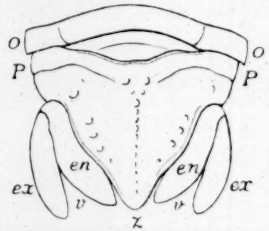


Diagram of posterior segments and telson (*z*) of *Cyclosphæroma*, with appendages restored.

o, last thoracic segment (vii). *P–z*, abdominal segments and telson. *v*, paired uropods or pleopods, appendages of last segment. *ex*, exopodite; *en*, endopodite. *z*, telson or terminal segment.

Having consulted my carcinological friend, the Rev. T. R. R. Stebbing, F.R.S., F.L.S., Tunbridge Wells, concerning the affinities of this fossil, I am glad to know that, in the absence of appendages to guide one more certainly, and from the general appearance of the body itself, he considers that I am fully justified in referring it to the Sphæromidæ.

He has further suggested that the forms among recent members of this family which appear to be most suitable for comparison with it are the following:—

1. Cassidina typa, H. Milne-Edwards.[1]

Hist. Nat. Crust., vol. iii, pp. 223–4, pl. xxxii, figs. 10–16.

Milne-Edwards speaks of the side-plates as ending in an almost straight edge, as in *Cyclosphæroma*.

2. Cassidina emarginata, Guèrin. (Pl. XIV, Fig. 3.)

This specimen is well represented in the British Museum by specimens from Otter Island collected by Dr. Cunningham in 1868,

[1] I could not obtain a spirit specimen of *C. typa*, so I decided to draw an example of *C. emarginata*, Guèrin, as preferable to reproducing a small and very indistinctly-drawn figure of the former species.

and from Kerguelen Island by the Rev. A. E. Eaton, and from Kelp, off Direction Hills, Pacific, 143½° E. long., 13° S. lat. (Dr. Cunningham).

This form shows very clearly the straight lateral margins of the epimera of the thoracic segments. The head in *Cyclosphæroma* is much larger than in *Cassidina*, and the general form of the body of the recent genus is more ovate and the head much more narrow in front than it is in the fossil form.

3. Cassidina maculata, Studer, (Pl. XIV, Fig. 4.)

Anhang. zu den Abhandlung. der k. Akad. der Wissensch. Berlin, 1883 (1884), p. 20, Tab. ii, fig. 7 (from Kerguelen Island).

The figure of *C. maculata* is after Studer, and I have unfortunately been unable to examine an actual specimen of this species. The form of the telson resembles that of *Cyclosphæroma*.

4. Sphæroma curtum, Leach. (Pl. XIV, Fig. 5.)

See "British Sessile-eyed Crustacea," Bate & Westwood, 1868, vol. ii, p. 412 (woodcut figure in text).

This specimen has been redrawn for me by Miss G. M. Woodward from an actual specimen from Devonshire, × 6 nat. size. In the straighter sides of the body, the broader head, the position of the eyes, the pointed form of the telson, and the finely granulated ornamentation of the body-segments, this little species comes very close to the Purbeck fossil.

5. Sphæroma gigas. (Pl. XIV, Fig. 6.)

From Kerguelen Island; × 2 nat. size.

This, like the preceding species of *Sphæroma*, offers many interesting points for comparison with the fossil form, in the broad head and the pointed telson, as well as in the finely granulated ornamentation of the body-segments.

Notwithstanding the fact that *Cyclosphæroma trilobatum* so far exceeds *Sphæroma gigas* and the great majority of living Sphæromids in size, yet the deep-sea dredge has brought to light several extremely large Isopods such as *Bathynomus* (*giganteus*?), dredged off the coast of Bombay in 696 fathoms (measuring about 4 inches in length and 2 inches in breadth), originally described by Professor Alphonse Milne-Edwards from the West Indies. (See *Comptes Rendus*, Paris, 6 January, 1879, p. 21. A translation of Milne-Edwards' paper appeared in the Ann. and Mag. Nat. Hist., ser. 5, vol. iii, pp. 241–243.)

Professor Alex. Agassiz writes: "From the collection made in the West Indian region only a single species of Isopod, *Bathynomus giganteus*, has been described, but this is *by far the largest Isopod known*, and is more than eleven inches long! The eyes of this giant are placed on the lower side of the head, and consist, according to

Milne-Edwards, of no less than four thousand facets." (See Agassiz, "Three Cruises of the 'Blake,'" vol. ii, 1888, pp. and figure.)

Although these recently discovered living deep-sea Isopods it very considerably in size, I think we may justly conclude th fossil *Cyclosphæroma* was in all probability also a deep-water

In comparing the fossil Sphæromid with various living Is one cannot fail to be struck with the resemblance it offers telson to the pointed and keeled terminal plate of the ple *Æga monophthalma* and in *Idotea*, particularly in *Idotea ent* but there the resemblance ceases, for in other respects this is an undoubted Sphæromid. One need not be surprised, ho to find in a Mesozoic form evidence of more generalized characters than now prevail in the family of the Sphæro to which we are led to refer it. One is only astonished t an Isopod resembling so nearly our existing Sphæromids, but back in time to the Purbeck and the Great Oolite rocks.

EXPLANATION OF PLATE XIV.

Fig. 1. *Cyclosphæroma trilobatum*, H. Woodw., 1890. Great Oolite: Northa Drawn of the natural size. The original specimen preserved in the Museum (Natural History). Jesson Collection.

Fig. 2. *Cyclosphæroma trilobatum*, H. Woodw., 1898. From the Purbec near Aylesbury; discovered by E. J. Garwood, Esq., M.A., F.G.S., b the original has been presented to the British Museum (Natural H Drawn of the natural size.

Fig. 3. *Cassidina emarginata*, Guèrin. Recent: Kerguelen Island. natural size. From a specimen in the British Museum.

Fig. 4. *Cassidina maculata*, Studer. Recent: Kerguelen Island. Copie Studer's figure.

Fig. 5. *Sphæroma curtum*, Leach. Coast of Devonshire. Six times natur From a specimen in the British Museum.

Fig. 6. *Sphæroma gigas*. Kerguelen Island. Drawn twice natural size. a specimen in the British Museum.

II.—On Scottish Rocks containing Orthite.

By John S. Flett, B.Sc., M.B., C.M.;
Assistant in Geology, University of Edinburgh.

FROM America and from many different localities on the con of Europe the occurrence of Orthite or Allanite as an acce mineral in crystalline rocks of different kinds has been frequ described. But so far it does not seem that its occurrence in Britain has been recognized, or at any rate I have failed to fin mention of it. Quite recently two instances of Scottish or bearing rocks have come under my notice which I wish to de briefly in the present communication. Both are in acid crystalline rocks—granites and gneisses—and in both it is asso with the closely allied mineral epidote, as is usually the case. specimens of the granite of Fell Hill I am indebted to Mr. J More, jun., M.Inst.C.E., Edinburgh, who sent sections of this for microscopic examination to Professor James Geikie, Edinb University. Although only two in number, the sections conta

least eight recognizable crystals of orthite, besides smaller pieces about the identity of which there might be room for doubt, and some of these are fortunately so cut as to render possible not only a certain identification of the mineral, but also a fairly complete account of its optical properties.

The granite of Fell Hill, Creetown, Kirkcudbrightshire, is shown on the 1 inch Ordnance Survey Map as occupying a small triangular area about a mile south of the town of Creetown on the shore of Wigtown Bay. In the hand-specimen it is a fine white granite, rich in black scales of biotite, with muscovite in subordinate quantity. The microscope shows it is a true granite with both muscovite and biotite. The principal felspar is orthoclase, which is sprinkled over with scales of muscovite, but microcline is also abundant, and an acid plagioclase is present in fair quantity. Micropegmatite is almost absent, and the rock shows distinct traces of shearing. The accessory minerals are apatite, zircon, iron ores, sphene, epidote, and orthite.

The epidote is very abundant, scattered through the whole slide in small grains which are often grouped in irregular aggregates, but do not show any evident idiomorphism. At the same time it seems in every way probable that the mineral is largely of primary origin, and not a product of the decomposition of the felspathic and ferro-magnesian constituents of the rock. These are too fresh to have produced epidote in such quantity, the biotite in particular being in good preservation and not greatly exceeding the epidote in amount. In several cases epidote is found in rounded grains enclosed in biotite; the mica is perfectly fresh, and around the epidote are broad pleochroic halos, such as are usually seen about embedded zircons. In such a case the epidote can hardly be other than primary in origin. For the most part the epidote is scattered over the felspar in such a way as to suggest its derivation from it. The usual cleavage is well seen in the larger epidote grains, and when they are elongated they usually have a straight extinction and yield the emergence of a bisectrix or of an axis. The twinning on the orthopinakoid which is so common in epidote was not observed in any section. It is almost colourless or very pale yellow in ordinary light, and the pleochroism is so faint as to be hardly noticeable, ranging from colourless to a pale greenish yellow. (a and β = colourless, γ = pale yellow.) The refraction and double refraction are both high, and in polarized light the colours are brilliant, except in those sections from the orthodiagonal zone which are nearly perpendicular to an axis, and such sections are by no means uncommon.

The orthite in thin section is deep brown in colour, and rather resembles hornblende and biotite when cut in certain directions, the more so as the outlines are sometimes hexagonal and resemble closely those of transverse sections of an amphibole prism. From hornblende, however, it is distinguished by its lack of cleavage and its faint dichroism, while, unlike basal sections of biotite (with which it would otherwise correspond), it does not yield the central emergence of a uniaxial cross in convergent polarized light. The mineral is

often zonal, bands of a paler and darker brown running parallel to the edges of the section. Unlike the epidote it usually accompanies, it has a strong tendency to idiomorphism, and its outlines are straight lines, evidently the traces of crystalline faces. But scattered through the epidote are many little brown flakes of irregular form, feeble pleochroism and strong double refraction, which in all probability are to be ascribed to orthite, though they cannot with certainty be determined as such. Two principal forms are to be recognized in the sections of this mineral, one of these being elongated, bounded by two parallel faces and having obtuse terminations. These have all a straight extinction, their axis of elongation being evidently the orthodiagonal. In convergent light they yield the emergence of an axis or bisectrix, and the optic axial plane is transverse to the length of the section or parallel to the plane of symmetry. The other typical section is that perpendicular to this (parallel to the optic axial plane), and in consequence showing neither axis nor bisectrix in convergent light. Its outlines are generally six-sided, though not of symmetrical shape. Its bounding faces seem to be the basal plane (001, M), the orthopinakoid (100. T), and an orthodome (101, r); at any rate, the measured angles in the sections giving the most oblique extinction, and hence most nearly perpendicular to this zone, show a fair approximation to the angles between these faces. Cleavage is either absent or too imperfect to yield any index to the faces present, but the face M is parallel to the principal cleavage of the associated epidote. In the section which gives the most oblique extinction the extinction angle is 34° in the acute angle between the vertical and clino-axes. One crystal is twinned simply, the twin plane being the orthopinakoid.

In convergent polarized light one section from the orthodiagonal zone yields a bisectrix, emerging in the centre of the field, the broad bar of which is coincident with the length of the section. Hence the optic axial plane is the plane of symmetry. In the diagonal position the apices of the hyperbolæ cannot be grasped by a dry lens, the angle 2 E being apparently great. This bisectrix is positive, but as an oil-immersion lens of 1·3 N.A fails to grasp the axes it must be the obtuse bisectrix, the acute bisectrix being a, and the mineral optically negative. We have, then, for the optic orientation $b = \mathfrak{b}$, $c : \mathfrak{a} = + 34°$.

The pleochroism of the mineral, while distinct, cannot be said to be strong, and may be expressed as follows:—

γ, brownish green.
β, yellow brown.
α, darker yellow brown.
Absorption: $\gamma > \alpha > \beta$.

The refraction and double refraction are both strong, the colours in polarized light being bright, but distinctly lower than those of the epidote in the same slice.

As already stated, the orthite occurs frequently in the midst of patches of epidote, sometimes in grains of ill-defined shape, more

usually in sharply idiomorphic crystals. The epidote is never idiomorphic, but from the parallel position of its principal (basal) cleavage with one of the faces of the orthite the association is undoubtedly that of parallel growth between two isomorphous minerals.[1] I failed to find sections parallel to the orthodiagonal in which both minerals extinguished in the same position. In most cases the extinctions were distinctly and even widely different. Some of the orthite crystals are apparently free from any epidote; in others there is a very narrow rim of a clear mineral which could not be identified, but is in all probability epidote; and around the twinned orthite this narrow border was also twinned, the composition plane being identical for both centre and margin. Finally, in the centre of the orthite crystals was frequently to be observed a pale rose-coloured mineral with slight dichroism and lower double refraction than either epidote or orthite. The orthite gives about the same polarization colours as the common green hornblende of granites, but this substance gave only pale greys and whites. It may be a product of the decomposition of orthite, than which it seems to be considerably softer, as it is often ground out of the interior of a crystal in preparing the section, while the orthite and epidote remain intact. It seems to vary somewhat in character, as between crossed nicols it never has uniform colours and extinction, and while irregularly cracked it has no definite cleavage. In one crystal it forms the whole centre, being ·24 millimetre in breadth; around it lies an orthite zone, sharply idiomorphic, and varying from ·01 to ·04 millimetre in breadth; around this, again, a clear zone, probably of epidote, ·02 millimetre broad, with its faces parallel to those of the orthite. All three minerals are twinned on the same plane, but they differ considerably in the obliquity of their extinction. The nature of this mineral I have been unable to determine. It may be a manganese epidote, which I think is hardly probable, or a product of the decomposition of orthite, although it should be noted that it is always found at the centre and not on the surface of the crystals.

A second instance of an orthite-bearing rock is to be found in the island of Sanday, almost in the extreme north-east of the Orkneys. Here there is a large erratic, which from its size has always attracted the attention of geologists visiting the county. It is known as the "Savil" boulder from the farm on which it lay; but the proprietor, Major Horwood, has recently had it removed and placed on the lawn at the front of the mansion house at Scar. In his "Geognosy of Orkney," part i,[2] Professor Heddle describes it as consisting of "white, finely striated oligoclase, the crystals of which are penetrated by fine filaments of actinolite; glassy quartz, in much smaller amount; dark-green, finely foliated, lustrous hornblende, in well-marked crystals; very little of a pale-green mica; a minute amount of crystals of a pale-brown mineral, which may,

[1] Hobbs, "Paragenesis of Epidote and Allanite": Amer. Journ. Sci., xxxviii, p. 223.

[2] Mineralogical Magazine, 1880, p. 127.

but does not appear to, be sphene; and a speck or two apparently of thorite." From the microscopic sections in my possession it seems to be a biotite gneiss consisting of orthoclase, microcline, and plagioclase, quartz, and biotite. A bright yellow epidote is very abundant in needle-like crystals which radiate from the iron ores and the mica, and form nests and strings running through the rock. Orthite is present in fair amount in large crystals, which are rounded and without trace of crystalline form, but here and there have parallel faces and a straight extinction, showing that the ortho-axis is the direction of elongation. In one or two crystals it is zonal, and an indistinct cleavage is to be made out. In convergent light it is widely biaxial and of negative sign. Its colour is brown, more intense than in the Fell Hill granite, and the pleochroism more marked, being—

γ, deep greenish brown.
β, dark yellow brown.
α, paler yellow brown.
Absorption: $\gamma > \beta > \alpha$.

Twinning and parallel growths with epidote were not observed.

Professor Heddle's opinion was that this is not a Scottish rock, and the microscopic evidence goes to support this view, for while similar rocks have not been described from Scotland they are well known in Sweden and Norway. A glance at the map given by Messrs. Peach and Horne in their paper on the Glaciation of the Orkney Islands[1] shows how close, in their opinion, the Norwegian and Swedish ice came to the Orkneys. In the south and west of the group they found many rocks in the Boulder-clay to which they could confidently ascribe a Scottish origin. It is in accordance with all we know about the glaciation of the Orkneys to believe that, at certain times at any rate, the north-east corner of the archipelago was overridden by Norwegian ice, and that this boulder is of Scandinavian derivation.

III.—On a supposed Tropical American Fish (*Poecilia*) from the Upper Miocene of Oeningen, Baden.

By Arthur Smith Woodward, F.L.S., F.G.S.

In 1861,[2] the late Dr. T. C. Winkler, of Haarlem, published a memoir on some fishes from the well-known Upper Miocene fresh-water formation of Oeningen, and among other new forms he believed he could recognize an extinct species of the Cyprinodont genus, *Poecilia*. This peculiar fish not being known elsewhere beyond the fresh waters of tropical America, the determination of a Miocene representative in a European fresh-water deposit excited some interest both among geologists and ichthyologists; and the occurrence of *Poecilia oeningensis* in Baden has been almost

[1] Quart. Journ. Geol. Soc., xxxvi, pl. xxvii.
[2] T. C. Winkler, "Description de quelques Nouvelles Espèces de Poissons Fossiles des Calcaires d'Eau Douce d'Oeningen" (Haarlem, 1861).

universally quoted in textbooks and treatises as a fact worthy of special note.

In his memoir Dr. Winkler mentions that he founds the species in question on a series of specimens, partly in the Teyler Museum, partly in the collection of Van Breda. As the latter collection was acquired by the British Museum in 1871, four of the specimens studied by Winkler are destined to be included in the forthcoming vol. iv of the "Catalogue of Fossil Fishes." They have thus been recently examined during the preparation of this work; and the result is so completely at variance with Winkler's interpretation of the fossils, that it seems advisable to publish an amended description of the fish without delay.

Among the specimens in the Van Breda collection, it is easy to recognize the original of Winkler's figure (op. cit., pl. iv, fig. 16), which is preserved in counterpart and numbered 42,779. The figure, however, seems to have been made by an artist without technical knowledge, and the description is evidently based upon this drawing, not upon the actual fossil. The general proportions of the fish are correctly indicated, and the imperfect remains of the head show little more than the drawing; but the fins are incompletely represented and the figure gives a false impression of their characters and arrangement. The pectoral fin is relatively large and comprises eleven slender spaced rays, which are divided distally: it is spread over the flank of the fish. The pelvic fins, not distinguished by Winkler, are relatively small; and the base of one, with indications of six rays, is observed directly beneath the base of the pectorals. There are quite clearly two dorsal fins, of which only the posterior is shown in the figure. The foremost dorsal is the smaller, and consists of six spinous rays, each supported by a dagger-shaped bone. The second dorsal comprises twelve rays, all of which are probably articulated and divided distally. The anal fin arises slightly further back than the second dorsal, and is somewhat smaller than the latter, with only nine rays, none spinous. The caudal fin is distinctly rounded, not forked.

Most of the characters thus briefly noted are also observed in the other specimens of the so-called *Poecilia* in the Van Breda collection. Moreover, the small clustered teeth are shown in the mandible of No. 42,778, while they appear among the remains of both jaws in Nos. 42,780–81. It is evident that there are four, possibly five, stout branchiostegal rays. There are also distinct indications of scales, with radiating markings on their covered portion, at least in the caudal region of the trunk.

It is thus obvious that the so-called *Poecilia oeningensis* is neither a member of the family Cyprinodontidæ nor a physostomous fish. It is indeed a typical Acanthopterygian, and is most suggestive of the families Cottidæ and Gobiidæ. In fact, if comparison be made with the small fish from Oeningen described by Agassiz under the name of *Cottus brevis*,[1] duly allowing for imperfections in preservation, it will at once be perceived that there are no essential differences

[1] L. Agassiz, "Poiss. Foss.," vol. iv, p. 185, pl. xxxii, figs. 2–4.

between the latter and the fish now under consideration. As remarked by Von Zittel [1] this species is to be placed in the genus *Lepidocottus* of Sauvage.[2] *Poecilia oeningensis*, Winkler, thus falls in the synonymy of *Lepidocottus brevis*, and is proved to be not an anomalous element in the Oeningen fauna, but a typical European form.

IV.—On some Cretaceous Shells from Egypt.

By R. Bullen Newton, F.G.S.

(PLATES XV AND XVI.)

A COLLECTION of Invertebrate fossils, obtained from various horizons and localities in Egypt and consisting principally of molluscan remains, has been sent home for examination and description by Captain H. G. Lyons, R.E., Director of the Geological Survey of that country.

The oldest specimens represented belong to Upper Cretaceous rocks, and are dealt with in the present communication. They include one species of Gasteropod and eight Lamellibranchs, two of the latter group being regarded as hitherto undescribed forms. It need hardly be stated here that most of our knowledge respecting these groups of Mollusca as represented in Egypt during this period has been ably summarized by Professor Dr. von Zittel, in his elaborate memoir, "Beiträge zur Geologie und Palaeontologie der Libyschen Wüste und der angrenzenden Gebiete von Aegypten," published in the *Palæontographica* for 1883. For subsequent details we are mainly indebted to the researches of Professor Mayer-Eymar and Prof. Johannes Walther: to the former for his monograph, "Zur Geologie Egyptens," [3] which includes a list of Cretaceous shells from the neighbourhood of the Great Pyramid; and to the latter for his paper, "L'Apparition de la Craie aux Environs des Pyramides," [4] containing a list of molluscan species from the same district and horizon, though particularly localized as Abu Roasch, Golea, etc.

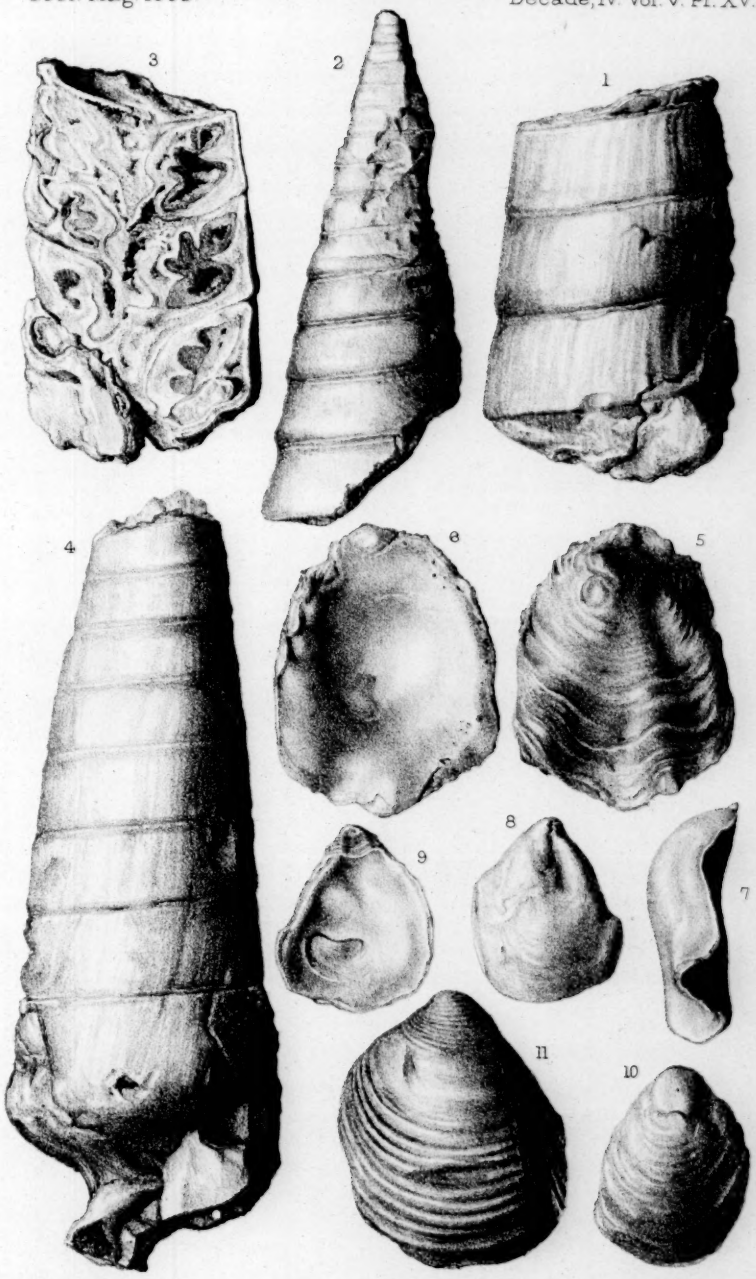
A paucity of Gasteropod species is noticeable in the faunistic lists of the Upper Cretaceous period of Egypt, with, however, a large representation of bivalve mollusca. The most abundant forms appear to belong to the genus *Ostrea* and its allies, a fact also observable in the corresponding faunas of Algeria and Tunis. In all three countries a similar conchological facies is apparent, whilst some species show a marked resemblance to Syrian forms. Certain difficulties have arisen in assigning a satisfactory horizon to the Egyptian species here discussed, though the evidence appears to be

[1] K. A. von Zittel, "Handbuch der Palaeontologie," vol. iii (1888), p. 310.

[2] H. E. Sauvage, "Sur le *Cottus aries* d'Aix-en-Provence": Bull. Soc. Géol. France, [3] vol. iii (1875), p. 637.

[3] Viert. Nat. Ges. Zurich, vol. xxxi (1886), p. 246: *Cucullæa Chiemensis*, Gümbel; *C. Ligeriensis*, Orb.; *C. tumida*, Orb.; *Cardium productum*, Sowerby; *Pholadomya Royanensis*, Orb.; *Nerinea Buchi*, Keferst.; *N. nobilis*, ? Münst.; *N. pyramidarum*, May.-Eym. (new); and *Acteonella voluta*, Münst.

[4] Bull. Inst. Egyptien, ser. 2, No. 8 (1888), p. 8: *Radiolites*; *Ostrea acanthonota*, Coq.; *O. Costei*, Coq.; *Plicatula Ferryi*, Coq.; *Nerinea*; and *Acteonella voluta*, Münst.



G.M. Woodward del. et lith. West, Newman imp.

Egyptian Cretaceous Fossils.

G.M. Woodward del et lith. West, Newman imp.

Egyptian Cretaceous Fossils.

in favour of a Turonian age—an opinion somewhat suggested by the palæontological work of M. Jules Welsch,[1] who has discovered in Algeria, *Sphærulites* (*Sauvagesia*) *Sharpei*, Bayle, a typical Turonian shell of Portugal, associated with *Ostrea acanthonota*, *O. Boucheroni*, etc. This author, therefore, inclines to the belief that the majority of Algerian species hitherto recognized by Coquand, Peron, and others as of Santonian age, are more probably Turonian. If this be accepted, then the Cretaceous rocks near Cairo (Abu Roasch, etc.), containing similar shells, which have been considered as Senonian by Schweinfurth, Walther, etc., should equally be regarded as Turonian, though apparently the Portuguese mollusc, *Sauvagesia Sharpei*, has not yet been identified in Egypt.

"Hills W. of Jebel Zait" and "Sheet 33" are districts given for other of the fossils referred to in this paper. The specimens from the former were probably obtained from the Cretaceous outliers occurring to the south-west of Jebel Zait (see Zittel's map), whilst those marked "Sheet 33" might come from the same area, on account of a similarity of matrix, although no explanation has been sent as to the region embraced in this particular division of the Egyptian map. These shells are likewise recognized as Turonian.

GASTEROPODA.

Genus NERINEA (Defrance), Blainville, 1825.

Dict. Sci. Nat., 1825, vol. xxxiv, p. 462, pl. xxxiv, fig. 3; Man. Malacologie, 1825, p. 404.

Type.—*Nerinea nodosa*, Voltz (= Nériné tuberculeuse, Defr.), [syn. *Helicoceras*, König, 1825].

Nerinea Requieniana, Orbigny. Pl. XV, Figs. 1–4.

Nerinea Requieniana, Orbigny: Pal. Française Terr. Crétacés, 1842, p. 94, pl. clxiii, figs. 1–3; Fraas: "Aus dem Orient," 1867, p. 96.

Nerinea pyramidarum, Mayer-Eymar, "Zur Geologie Egyptens": Viert. Nat. Ges. Zurich, 1886, vol. xxxi, p. 246.

Description.—*Testa elongato-conico, imperforata; spira, angulo* 21°; *anfractibus angustatis, lævigatis, inferne limbatis; apertura subquadrata, 5-lobata; labro 1-plicato; columella 3-plicata.* (Orbigny.)

The above original diagnosis applies to a species of large size, slightly pupoid, compressed, non-umbilicated, and with numerous whorls (about 20); the whorls are depressed, slightly concave, and convexly margined at the base; sutural band narrow (1 mm. wide), sunken, and immediately below the rounded edge of the whorl; surface bearing longitudinal striations, inflected near the suture, and more apparent on the later than on the earlier whorls; aperture subquadrate, with a prominent, nearly central tooth on the

[1] J. Welsch, Bull. Soc. Géol. France, ser. 3, vol. xviii (1890), p. 493; ser. 3, vol. xxv (1897), p. 554; and P. Choffat, ibid., ser. 3, vol. xxv (1897), p. 470.

labrum; columella provided with three plications; anterior canal short, twisted; spiral angle diminishing with growth.

Dimensions.

Length	120 mm.
Spiral angle	20° to 15°
Sutural angle	85°

The present specimens, although rather fragmentary and crystalline, are sharp, well-defined, and exhibit both internally and otherwise all the characters of this species. One piece shows the early condition of the spire with an angularity of 20°, while a later portion has a spiral angle of 15°. An oval section seen in a transverse fracture of another specimen clearly indicates a compression of the spire. The width of the whorls increases from 1 mm. to 16 mm.

Remarks.—In his monograph on the Geology of Egypt, Professor Mayer-Eymar refers to the great abundance of a new *Nerinea*, under the name of *N. pyramidarum*, in rocks of Senonian age occurring W.N.W. of the Great Pyramid. He regards it as an intermediate form between *N. nobilis* and *N. Buchi*, having oblique ribs, more or less obsolete, on the earlier part of the spire, with a tendency to a marginal thickness of the whorls. Although no figure accompanies his brief remarks, there is little doubt that this shell, with the characters alluded to, is identical with D'Orbigny's *Nerinea Requieniana*, which according to the original account was not peculiar to European areas alone, but had also been found in Egypt by a M. Lefebvre.

Some of the specimens are encrusted with concentric chalcedony ("Beekite"), the matrix being a yellowish-white limestone.

Horizon.—Turonian.

Distribution.—Various localities in the west and south-west of France; environs of Jerusalem; W.N.W. of the Great Pyramid; Abu Roasch: Coll. Geol. Surv. Egypt (No. 63, Box No. 32*c*); and Coll. British Museum, G. 11,485.

LAMELLIBRANCHIATA.

Genus OSTREA, Linnæus.

Systema Naturæ, 1758, ed. 10, p. 696.

Type.—*O. edulis*, Linnæus.

Ostrea acanthonota, Coquand.

Ostrea acanthonota, Coquand: "Mon. genre *Ostrea* Crétacé," 1869, p. 103, pl. xxxviii, figs. 1–4. Walther, "L'Apparition de la Craie environs Pyramides": Bull. Inst. Egyptien, 1888, ser. 2, No. 8, p. 8.

Description. — Shell subequivalve, oblong, convex, arched; valves ornamented with prominent ribs, which commence a short way from the beaks and afterwards bifurcate; ribs regular, angulose, imbricated, obtusely spined, and separated by deep and wide grooves; summits ostreiform, equal; muscular scar nearly central, antero-lateral.

DIMENSIONS.

Largest specimen (both valves)—Height	103 mm.	
Length	73 ,,	
Diameter	68 ,,	

This species has certain resemblances to *O. dichotoma*, Bayle, an Algerian shell, but differs from it in being curved or arched and possessing a rough spiny exterior. It may be compared also with another Algerian species, *O. syphax*, which, however, has more or less exogyriform umbones, especially during the earlier period of its development.

REMARKS.—It is interesting to note that M. Peron, in his work on the Cretaceous Mollusca of Tunis, has united the two species *O. dichotoma* and *O. acanthonota*, but for present purposes it seems desirable to regard them as separate forms. The Egyptian examples of this species are in a splendid state of preservation and consist of both old and young shells. The matrix is a soft white limestone, resembling chalk.

HORIZON.—Turonian.

DISTRIBUTION.—Algeria; Golea, west of Abu Roasch; west of the Gizeh Pyramids: Coll. Geol. Surv. Egypt (No. 64, Box No. 31*c*).

OSTREA LYONSI, sp. nov. Pl. XV, Figs. 5–7.

DESCRIPTION.—Species oblong, oval, small, and of variable dimensions; lower valve convex, lamellose, and prominently plicated; ligamented area narrow, small, triangular, and rather oblique; muscular scar antero-ventral, semilunate, and concentrically striated; upper valve depressed, possessing moderately deep marginal plications, and ornamented with concentric growth-lines.

DIMENSIONS.

Largest lower valve—Height	40 mm.
Length	30 ,,
Diameter	14 ,,

This is a very distinctive form of *Ostrea*, which appears to differ in many details from other species. The lower valve is often much inflated at the umbones, where it has a steep flattened adherent surface; the plications are rounded, elevated, few (four or five), and most prominent at the ventral margin. The valves, according to age, differ a good deal in relative convexity, many being depressed. The species is related to *O. Nicaisei*, Coquand, from the Cretaceous of Algeria, which is of a similarly lamellose structure and having the same kind of widely distant plications, but differing in its flatter and more equally convex valves, as well as in its generally more circular shape.

REMARKS.—From the number of specimens sent for determination, this species may be regarded as fairly abundant. The shells, largely mineralized with incrustations of "Beekite," are found in a grey compact limestone associated with *Arctica Barroisi*, as well as in a softer limestone of a fawn colour.

HORIZON.—Turonian.

DISTRIBUTION.—Hills west of Jebel Zait: Coll. Geol. Surv. Egypt (No. 637, Box No. 48*a*).

OSTREA VILLEI, Coquand. Pl. XVI, Figs. 1–3.

Ostrea Villei, Coquand: "Géol. Paléont. Constantine," 1862, p. 231, pl. xxii, figs. 1–4.
O. bomilicaris, Coquand: ibid., p. 230, pl. xxi, figs. 4–6.
O. Villei, Coquand: "Mon. genre *Ostrea* Crétacé," 1869, p. 27, pl. iv, figs. 1–8; pl. v, figs. 1–4.
O. bomilicaris, Coquand: ibid., p. 24, pl. ii, figs. 12–15.
O. Villei, Peron, "Desc. Moll. Foss. Crétacés Tunisie": Explor. Sci. Tunisie, pt. ii (1891), p. 182.

DESCRIPTION.—Shell of subtriangular or triangular contour, inequivalve; lower valve convex, ornamented with numerous regular, bifurcating ribs, separated by deep grooves and sometimes provided with a smooth surface of attachment at the umbonal region; upper valve of less convexity than the lower and similarly ornamented; muscular impression large, oval and ventral.

DIMENSIONS.

		Upper valve.	Lower valve.
Medium-sized single valves—Height	...	45 mm.	40 mm.
Length	...	45 ,,	40 ,,
Diameter	...	10 ,,	21 ,,

Several isolated valves of this species are in the collection, and vary somewhat in their characters. They all, however, preserve the more or less triangular shape and the bifurcated character of the ribs. The lower valve is considerably arched, whilst the other is only moderately convex and more often depressed; most of the valves exhibit the characteristic enlargement of the pallial area, with frequently decided lateral extensions.

REMARKS.—Coquand's two species, *Ostrea bomilicaris* and *O. Villei*, have been united under the latter name, on account of their similar characters, by M. Peron. A careful comparison of specimens in the British Museum, and a study of the figures of this species given by Coquand and others, appear to confirm the correctness of the present determination, although the shell does not seem to have been heretofore recorded from Egypt. It occurs in soft and hard varieties of a fawn-coloured sandstone. This harder matrix, identical with that containing *Trigonoarca multidentata* and *Protocardia biseriata*, shows also a fragment of bone of probably reptilian origin, but which Mr. A. S. Woodward informs me is not determinable.[1] Other examples of this oyster are met with in a grey, compact limestone, encrusted with "Beekite," being the same material as contains *Arctica Barroisi* and *Ostrea Lyonsi*.

HORIZON.—Turonian.

DISTRIBUTION.—Algeria; Tunis; and "Sheet 33": Coll. Geol. Surv. Egypt (No. 1,043, Box No. 55*c*).

[1] It may be incidentally mentioned that remains of *Mosasaurus* have been recorded from the Cretaceous rocks of Wadi Ouh, near El Radsieh, Egypt, by Figari Bey ("Studii Scientifici Egitto," vol. i, 1864, p. 29), which were subsequently identified by Zittel as *Mosasaurus mosensis* ("Beit. Geol. Pal. libysch. Wüste": Palæontographica, pt. i, 1883, p. lxxvii), but, as far as can be ascertained, no figures or description of this species have yet been published.

OSTREA THOMASI, Peron. Pl. XV, Figs. 8–10.

Ostrea Brossardi, Coquand: "Mon. genre *Ostrea* Crétacé," 1869, p. 45, pl. x, figs. 18, 19, *non* figs. 15–17.

Ostrea Thomasi, Peron, "Desc. Moll. Foss. Crétacés Tunisie": Explor. Sci. Tunisie, pt. ii (1891), p. 167.

DESCRIPTION.—Shell small, irregularly inflated; narrow, straight, enlarged in rear but always tapering at the beaks; lower valve more convex than the upper, both ornamented with lamellose, concentric, and often irregular striæ, with no indication of radial markings.

DIMENSIONS.

Lower valve—Height	27 mm.
Length	21 ,,
Diameter	10 ,,

Several isolated valves of this small oyster are represented in the Egyptian Collection, and they resemble in every detail Coquand's figures (18 and 19) and agree with certain parts of his description, as well as with the later account furnished by M. Peron. This last-named author very properly separated two distinct forms which Coquand recognized under the one name of *O. Brossardi*, and founded the species *O. Thomasi* for the smaller specimens represented by Coquand's figures 18 and 19, which showed the tapering beaks and were entirely without radial structure.

REMARKS.—The species may be said to slightly resemble young forms of *O. vesicularis* and *O. Boucheroni*, and from the number sent for determination it appears to be fairly abundant in Egypt. The specimens are of a light-grey colour and entirely free from matrix. The shell does not occur in Tunis, although its history has been discussed by M. Peron.

HORIZON.—Turonian.

DISTRIBUTION.—Algeria; west of the Gizeh Pyramids: Coll. Geol. Surv. Egypt (No. 61, Box No. 29*c*).

Genus GRYPHÆA, Lamarck, 1801.

Syst. Anim. sans Vert., 1801, p. 398.

TYPE.—*Gryphæa angulata*, Lamarck.

GRYPHÆA COSTEI, Coquand.

Ostrea Costei, Coquand: "Mon. genre *Ostrea* Crétacé," 1869, p. 108, pl. xxvi, figs. 3–5; pl. xxxviii, figs. 13, 14.

Gryphæa Costei, Stoliczka, "Cretaceous Pelecypoda Southern India": Mem. Geol. Surv. India, vol. iii (1871), p. 457.

Ostrea Costei, Walther, "L'Apparition de la Craie environs Pyramides": Bull. Inst. Egyptien, 1888, ser. 2, No. 8, p. 8. Peron, "Desc. Moll. Foss. Crétacés Tunisie": Explor. Sci. Tunisie, pt. ii (1891), p. 140.

DESCRIPTION.—Shell globulose, thick, sometimes longer than wide, and *vice versa*, and having a postero-lateral expansion; lower valve very convex, with a large adherent surface, and ornamented

with concentric, lamellose, irregular growth-lines crossed by numerous obscure plications; upper valve concave, truncated at the summit, operculiform, and of similar sculpture to the opposing valve, but without radial ornamentation.

DIMENSIONS.

Both valves in contact—Height	... ...	82 mm.
Length	... ...	101 ,,
Diameter	... ...	45 ,,

The shells referred to this species have very robust, thick tests, and vary somewhat in size. From *O. biauriculata* and other allied species, they differ in the possession of radial costæ and the usually scaly appearance of the lower valve. On account of the presence of a posterior expansion, this species is placed in the genus *Gryphæa*, a view first adopted by Stoliczka.[1]

REMARKS.—All the specimens are in a fine state of preservation, and what little matrix accompanies them is a yellowish-white limestone.

HORIZON.—Turonian.

DISTRIBUTION.—Algeria; Tunis; Golea, westward of Abu Roasch, Egypt; west of Gizeh Pyramids: Coll. Geol. Surv. Egypt (No. 68, Box No. 30*c*).

Genus PROTOCARDIA, Beyrich, 1845.

Zeitschrift Malakozoologie (Hanover), 1846, p. 17.

TYPE.—*Cardium Hillanum*, J. Sowerby.

PROTOCARDIA BISERIATA, Conrad. Pl. XV, Fig. 11.

Cardium biseriatum, Conrad, "Desc. Fossils Syria": Official Report United States Exped. Dead Sea, etc. (W. F. Lynch), 1852, p. 216, pl. vi, figs. 38, 39 (*non* fig. 40).

Cardium (*Protocardia*) *Hillanum*, Hamlin, "Syrian Molluscan Fossils": Mem. Mus. Comp. Zool. Harvard College, vol. x (1884), p. 50.

Protocardia Hillana, var. *typica*, Blanckenhorn: "Beiträge Geologie Syriens," 1890, p. 89.

DESCRIPTION.—Shell "rotundate-cordate; ventricose, subequilateral; posterior side rather longer than the anterior; the margin subtruncated and nearly direct; summits prominent, acutely rounded; basal margin profoundly rounded anteriorly, obliquely truncated in rear; surface of the valves marked with concentric lines as far as the umbonal slope; posterior submargin with about fifteen slender minutely echinated radii; posterior margin crenulated within. This abundant species resembles *Cardium peregrinosum*, Orbigny, and *C. Hillanum*, Sowerby, but is proportionally more elongated, and the sulci are much larger. The largest specimen measures $2\frac{1}{2}$ inches in length."—*Conrad.*

[1] It should be stated here that *G. Costei* is only quoted by Stoliczka in a general list of Cretaceous species, and not as occurring in India, where, apparently, it has never been identified.

The above represents Conrad's original account of a Lebanon shell which was regarded as Jurassic, but which later authorities have more correctly recognized as Cretaceous (Turonian of Hamlin). Certain specimens in the Egyptian Collection exhibit the sculpture of this species. The broad, convex, concentric ribs are each separated by a furrow of lesser width, whilst a series of radial costæ ornament the oblique posterior area. The concentric striæ are finer, closer together, and more numerous on the umbonal region than in a more ventral direction. The species is closely related to *Cardium Hillanum* of Sowerby, from the Blackdown Beds of England, and seems to differ chiefly in its coarser and more deeply sulcated concentric ornamentation.

DIMENSIONS.

Single valve—	Height	45 mm.
	Length	44 ,,
	Diameter	15 ,,

REMARKS.—The valves occur in a fawn-coloured sandstone, and are associated with *Trigonoarca multidentata* and one of the specimens of *Ostrea Villei*. They are partially covered with matrix, so that the posterior areas are not seen in all cases.

HORIZON.—Turonian.

DISTRIBUTION.—Bhamdûn, Mount Lebanon, Syria; and "Sheet 33": Coll. Geol. Surv. Egypt (No. 1,042, Box No. 54*c*; No. 1,044, Box No. 56*c*).

Genus TRIGONOARCA, Conrad, 1867.

American Journ. Conch., vol. iii (1867), p. 9.
Journ. Ac. Nat. Sci. Philadelphia, ser. 2, vol. iv (1860), p. 281, pl. xlvii, fig. 20.

TYPE.—*Cucullæa Maconensis*, Conrad.

TRIGONOARCA MULTIDENTATA, sp. nov. Pl. XVI, Fig. 4.

DESCRIPTION.—Shell subtrigonal, arched, anterior margin rounded, posterior area obtusely angulated and abruptly truncated; cardinal region nearly semicircular, composed of numerous, slightly flexuous, radiately arranged, elongate, depressed denticles, which extend down each side to the ventral margin of the adductor scars; scars large, posterior one longest and furnished with a projecting marginal edge; surface with more or less distant concentric growth-lines, which are crossed in the ventral area by nearly obsolete radial costæ.

DIMENSIONS.

Left valve—	Height	75 mm.
	Length	79 ,,
	Diameter	25 ,,

These characters have been drawn up from a single left valve which represents the only specimen in the collection. Although more or less of the nature of a cast, it is in a fair state of preservation, and is distinguished from all other forms by the regular formation and enormous number of the closely arranged

teeth, which amount to about 65. These teeth have depressed summits, hook-shaped ends, and are longest on the anterior side, besides being of almost vertical disposition at the umbo. In these details it differs from *Cucullæa tumida* of D'Archiac, a shell which in some other characters appears to show certain resemblances, though of less size and less inflated. It is of interest to mention that *C. tumida* has already been recorded from the Senonian rocks of Egypt by Professor Mayer-Eymar.[1]

Remarks.—The specimen is contained in the same fawn-coloured sandstone as *Protocardia biseriata* and a valve of *Ostrea Villei*. Conrad's genus *Trigonoarca* is essentially Cretaceous, and from the peculiar character of its teeth appears to be related to *Cucullæa*, *Axinea*, and *Noetia*.

Horizon.—Turonian.

Distribution.—"Sheet 33": Coll. Geol. Surv. Egypt (No. 1,044, Box No. 56*c*).

Genus ARCTICA, Schumacher, 1817.

Nouv. Syst. Hab. Test., 1817, p. 145.

Type.—*Venus Islandica*, Linnæus [syn. *Cyprina*, Lamarck, *non* Linnæus].

Arctica Barroisi, Coquand. Pl. XVI, Fig. 5.

Cyprina Barroisi, Coquand, "Études Suppl. Pal. Algérienne": Bull. Ac. Hippone (Bone), No. 15 (1880), p. 113 (not figured). Peron: "Desc. Moll. Foss. Crétacés Tunisie," pt. ii (1891), p. 298, pl. xxix, figs. 8, 9.

Description.—Shell triangular, thick, very convex, higher than wide, marked by concentric striations, inæquilateral; anterior side short, excavated beneath the umbones; posterior region long, narrow, rounded at margin; umbones prominent, incurved; muscular scars prominent.

Coquand's original diagnosis of this species as here given was founded upon specimens obtained from the so-called Santonian beds of Algeria, but without being represented by figures. The excellent illustrations, however, given by M. Peron, of the same shell from Tunis, help to supply this omission in the history of the species. It is evidently chiefly found as a cast, for the excavation beneath the beaks is very apparent, not only in Peron's figures, but also in actual specimens from Tunis preserved in the British Museum. Furthermore, neither Coquand nor Peron refer to internal characters, but one of the present Egyptian specimens exhibits a great width of hinge-area and shows the lower of the two anterior teeth; and, although somewhat obscure in details, the hinge-area may be said to resemble what is present in such forms as *Arctica rostrata* (Sowerby), etc.

The species is related to *Cyprina cordiformis* of D'Orbigny, a European Albian shell, which, however, has prominent radial striæ in addition to concentric ornamentation on its valves, besides

[1] "Zur Geologie Egyptens": Viert. Nat. Ges. Zurich, vol. xxxi (1886), p. 246.

being of greater length than height, and having an increased diameter.

DIMENSIONS.

Largest valve—Height	... ...	71 mm.
Length	... ...	61 ,,
Diameter	... ...	24 ,,

REMARKS.—The Egyptian examples consist of two opposite valves, belonging to distinct individuals. They are contained in a grey compact limestone associated with "Beekite," and exactly similar to the matrix bearing a valve of *Ostrea Lyonsi* and a specimen of *O. Villei*.

HORIZON.—Turonian.

DISTRIBUTION.—Algeria; Tunis; and "Sheet 33": Coll. Geol. Surv. Egypt (No. 1,044, Box No. 56*c*).

EXPLANATION OF PLATE XV.

NERINEA REQUIENIANA, Orb.
Turonian of Abu Roasch.

FIG. 1. Fragment from near the base, showing obscure ribbing and marginal thickening of the whorls.
FIG. 2. Upper portion of spire, with its numerous whorls.
FIG. 3. Vertical section of Fig. 1, exhibiting the plicated structure of columella,
FIG. 4. Front aspect of a weathered specimen in the British Museum, presented by W. M. Newton, Esq. [G. 11,485].

OSTREA LYONSI, sp. nov.
Turonian, from hills west of Jebel Zait.

FIG. 5. External view of lower valve.
FIG. 6. Inner view of same.
FIG. 7. Profile of a natural cast of interior of another specimen, showing the plicated character of the valves.

OSTREA THOMASI, Peron.
Turonian, west of the Gizeh Pyramids.

FIG. 8. External view of upper valve.
FIG. 9. Internal view of same.
FIG. 10. External view of lower valve of another specimen.

PROTOCARDIA BISERIATA, Conrad.
Turonian, "Sheet 33."

FIG. 11. External aspect of a left valve, showing the concentric and postero-radial sculpture.

EXPLANATION OF PLATE XVI.

OSTREA VILLEI, Coquand.
Turonian, "Sheet 33."

FIG. 1. External view of lower valve.
FIG. 2. Internal view of upper valve.
FIG. 3. Exterior of Fig. 2.

TRIGONOARCA MULTIDENTATA, sp. nov.
Turonian, "Sheet 33."

FIG. 4. External view of a left valve, showing dentition, scars, etc.

ARCTICA BARROISI, Coquand.
Turonian, "Sheet 33."

FIG. 5. External view of a left valve, exhibiting the regular concentric sculpture of the species.

(The figures on both plates are drawn natural size.)

V.—Memoranda chiefly on the Drift Deposits in various parts of England and Wales: being Extracts from the Notebooks and other MSS. of the late Sir Joseph Prestwich, M.A., D.C.L., F.R.S., etc.

Communicated by Lady Prestwich, and edited by H. B. Woodward, F.R.S.

[For a period of nearly sixty years Sir Joseph Prestwich recorded his geological observations in a series of notebooks. These records, together with the illustrative sections, were afterwards copied, in many instances, into folio volumes dealing respectively with the Eocene and Miocene, the Pliocene and Post-Pliocene formations, and with well-sinkings, springs, etc. The systematic arrangement and indexing of his very copious notes no doubt greatly facilitated the labours of the author. The majority of his notes and sections have been published, but here and there among the notebooks and MSS. there are records of pits and railway-cuttings, as well as some statements of opinion, which appear never to have been printed. A selection of these is now given, together with references to published papers dealing with the same subjects. All additions are put in square brackets.

It was the desire of Sir J. Prestwich to have dealt more fully with the phenomena of the Glacial Period, but owing to the many calls upon his time, and to his aim invariably to obtain and to submit fully to his readers all the evidence bearing upon his subjects, he was led to postpone for many years his more elaborate works. Thus his important papers on the Crag formations were issued long after most of his observations had been made. Meanwhile other geologists had entered the field and made known many of the facts which he had previously gathered, a proceeding natural enough and one by no means to be regretted. Thus Sir J. Prestwich remarks in his paper on the Westleton Beds, Part I (Quart. Journ. Geol. Soc., vol. xlvi, 1890, p. 86), that "The Memoirs of the [Geological] Survey, to which I shall have frequent occasion to refer, now supply a mass of valuable details, which greatly facilitate the task and do away with the necessity of much local description."

The notebooks rarely contain any particular expressions of opinion; they simply record facts and only occasionally suggest correlations. The conclusions were for the most part worked out subsequently and embodied in various published papers.

Among the MSS. left by Prestwich is the rough draft of the Table of Contents of a paper dated 1892. It includes the following heads:—]

On the Glacial Series of the South of England.

The history of the Westleton Beds showed that the valleys of the South of England were excavated subsequently to them.

The Westleton the base of the Quaternary or Glacial. The Rubble Drift the last term. These are two definite horizons.

The Westleton followed by elevation.

Subaerial action commenced in the west, while marine action continued on the east coast.

Distribution of Glacial beds affected thereby.

Abrupt setting in of Lower Boulder-clay on the Westleton Beds.

Gradual rise of land westward—a slow process.

On the Lower Glacial Series.

I have shown[1] that, during the deposition of the Westleton Shingle, a movement of depression of the surface from eastward to westward caused it to pass transgressively over the Crag series of the Eastern Counties and the Lower Tertiaries of Essex and

[1] Quart. Journ. Geol. Soc., vol. xlvi (1890), pp. 114, 148, 178.

adjacent counties, as far westward as Wiltshire, if not beyond. This was succeeded at the end of the Westleton epoch by a movement of elevation which raised that sea-bed from nearly its then level on the east coast gradually to a height of 600 to 650 feet in a north-westerly direction in Buckinghamshire, Oxfordshire, and Berkshire.

The physical and structural features by which I traced this bed thus far cease on the north-western brow of the Chalk escarpment—cease with the range of the Chalk and Tertiary strata on which it rests. I have sought for it on the high grounds in the north of these and other Midland counties, but without success. The denudation which swept away the underlying Chalk and Tertiaries has not left a trace of the Westleton Beds.

It is, however, a curious circumstance that if we take the Westleton Shingle in South Essex where it is [160 to 200][1] feet above the sea-level, and its outliers on the Chalk escarpment where it is 650 feet high, and prolong this gradient to Derbyshire and North Wales, it will be found to accord very nearly with the levels of the fossiliferous gravel above Macclesfield and with the shelly sands on Moel Tryfaen.

[Comparisons were then to be made between the Marine Mollusca recorded from the Westleton Beds, Quart. Journ. Geol. Soc., vol. xlvi, p. 116, and the species obtained from Moel Tryfaen and Macclesfield, but the references were not completed.]

[The MS. of a portion of another paper was commenced by Prestwich, and five pages of foolscap were written by him on Nov. 1st, 1895, the day when he was seized with his last illness. The paper commences as follows:—]

On some Local Fresh-water Deposits underlying the Glacial Series in the South of England.

In succession to the Westleton Beds, and following on the changes of level which then took place, are a few local deposits which are important as indicating the nature and extent of those changes. Overlaid, however, as they are generally by the Glacial series they are rarely to be seen. In fact, the overlying Glacial series has generally worn into and denuded these soft fresh-water beds so that they are to be met with in very few places. They are sufficient, however, to prove the fact.

[Among these fresh-water beds the author would include the shell-marl underlying the brickearth at Witham in Essex. See Wood & Harmer, Quart. Journ. Geol. Soc., vol. xxxiii, p. 110; Prestwich, ibid., vol. xlvi, p. 135; and Whitaker, "Geology N.W. Part of Essex," Geol. Survey, pp. 67–69. The deposit is usually considered to be newer than the Boulder-clay of the locality.

He also refers to the fresh-water deposit at Casewick in Lincolnshire, long ago described by Professor Morris, and referred to by Professor Judd ("Geol. Rutland," p. 244) as a "Pre-glacial? Lacustrine deposit." Mr. Clement Reid has recently named a few plants, obtained by him from a lump of the Casewick clay, which was given to him by Prestwich. Mr. Reid says: "There is nothing in the list to throw any light on the age of the deposit, and so far as the flora shows it may be of extremely recent date" (Quart. Journ. Geol. Soc., vol. liii, p. 463).]

[1] [Quart. Journ. Geol. Soc., vol. xlvi, p. 135.]

[The following are extracts from Notebooks:—]

1. Thames Valley and Eastern Counties.

Aug. 19, 1849.—With Morris through Kensington. Half-way up the hill leading to the waterworks a bed of light-coloured sand crops out. Mr. Earle says that is underlaid by gravel. A short distance above this the ochreous gravel, which is very irregular, sets in.

[The general section of the hill is thus stated:—]

Mixed yellow clay and gravel.
Compact gravel, ochreous.
Light-coloured sands.
? Gravel.
London Clay.

At the old Kensington gravel-pits brickearth now only is worked. [The brickearth is shown in diagram to rest partly on the gravel and partly on London Clay.]

Kensington Park Villas, the old Hippodrome-ground, shows the bare London Clay coming to the surface.

At the foot of Notting Hill the valley drift shows beds of loam and brickearth which are largely worked.

South of the Kensington Road, by the side of the canal, thick beds of ochreous gravel again appear. [Section given of] Bright ochreous gravel of angular and rolled flints, roughly bedded, with irregular sandy beds, 12 feet. Bones are said to have been found in the pit. Could not by sight distinguish this gravel, which is in the valley, from that on the top of the hill.

Aug. 30, 1853.—With [R. W.] Mylne to Kensington gravel-pits. It is doubtful whether the gravel caps the hill at the reservoir. The brickearth goes close up to it; the surface of the clay is also mixed with gravel. In the Queen's Road the gravel is 15 to 20 feet thick, and is of a brown ferruginous colour, very compact, and with only a few sand-veins of the same colour.

Resumed the following day [August 31] at the corner of the Addison Road. Passing thence into Potter's Field we found a brickearth 10 to 16 feet thick, underlaid by a light quicksand, and then gravel a few feet thick and full of water. This brickearth is remarkable for its resemblance to the London [Clay]; it is this remanié. The outcrop of the gravel is not visible [being concealed by overlap of brickearth on to London Clay]. In an old brickfield at Shepherd's Bush we found some of the gravel in a heap. It contained the same foreign rocks [New Red Sandstone débris] as are found in the gravel at West Drayton; differs from that in Hyde Park.

Mammalian remains have not been found in the brickearth at Potter's Field, but they have been found in the gravel near Shepherd's Bush.

1853.—With Mylne to Chelsea to see the sewer now making on the west of the Hospital. [The section noted was:—]

Earth	1 foot.
Bright ferruginous gravel, chiefly subangular flints ...	23 feet.
Yellow and ochreous gravel	
Yellow loam, 2 [feet]	
Light-coloured sharp gravel, with mammalian remains	

In the upper part of the gravel there are few quartz, etc., pebbles. In the lower part quartz and sandstone (quartzite) pebbles are common. The mammalian remains consist of ox, horse, and stag.

1853.—To section west of Shepherd's Bush. Brickearth very much like London Clay, [resting irregularly on] ochreous gravel. The lower part of the brickearth is lighter and full of 'race.' This also is the case at the Addison Road pits, where the brickearth is 10 to 12 feet thick, and the gravel not worked on account of water.

1889.—[Notes section at] Castle Hill, Ealing, pit by side of railway, showing London Clay remanié, with a few flints and flint-pebbles, 2 to 4 feet; [resting on] ochreous flint gravel, 15 feet.

[The occurrence of remanié London Clay at Hendon and elsewhere has been noted by Dr. Hicks: Quart. Journ. Geol. Soc., vols. xlvii, p. 575; xlviii, p. 460. See also J. Allen Brown: Proc. Geol. Assoc., vol. vii, p. 173; and Quart. Journ. Geol. Soc., vol. xlii, p. 192.]

1859.—[Notes the following section at] Victoria Road gravel-pits, Clapham Common:—

	Feet.
Earth and flints	1
Brickearth	4
Sand and gravel	9
London Clay—Brown clay	1
Blue clay	

Visited the above with General Emmet. . . . . [Found] a cast of shell in a New Red Sandstone pebble. . . . . No bones found here.

Thence to Wandsworth Common pit, near top of Nightingale Lane. Bones found under gravel on top of clay. Could not make out species; brown and mineralized.

No Date.—[Mentions that] great quantities of peat were taken out during the digging of the foundations of the Westminster Palace Hotel in Victoria Street.

N. D.—[Between Highbury and Barnsbury the railway-cuttings showed gravel and loam resting irregularly on London Clay. In places the London Clay comes to the surface.]

The gravel consists of brown clay and ochreous sand, with more or fewer white and black Tertiary flint-pebbles; scarcely a subangular flint to be found. No stratification. The pebbles at all angles, some upright. They more resemble the pebbles of the Bagshot Beds. At places where the sand and pebbles are scarce or disappear, the drift passes into what looks merely as remanié London Clay.

Sept. 29, 1861.—With [Alfred] Tylor to Highbury. Between Balls Pond and Highbury:—

Black pebble-gravel and a few subangular flints [in pockets] ...	6 to 8 feet.
Brown clay	
Fine yellow sand, a few small flints	9 to 10 feet.

At the back of the new road by the Canal [New River] :—

Brown clay	3 feet.
Gravel [in pockets]	2 to 3 feet.
Sand and clay	1 to 2 feet.
Yellow sand	

Pit in centre of field :—

	ft.	in.
Brown clay ... ... } Gravel ... ... }	4	0
Light greenish-grey clay	1	6
Yellow clay	1	6
Peaty bed	0	6
Brown clay	3	0
Yellow sand		

Large pit behind Highbury Barn :—

	ft.	in.
Brown clay—London Clay remanié ... ... } Gravel [in pockets] ... ... } Yellow sandy and brown clay and seams of gravel }	8 to 10	0
Grey and brown clay and ferruginous gravel in thin seams	4	0
Peaty seam	0	6
Ferruginous sand and small gravel	1	6
Brown clay banded with grey clay	3	6
Peaty clay and angular black flints	2	0
Brown clay	1	0
Light brown sand	1	0
Laminated clay	2	0
Fine light yellow sand	10	0

Could find no shells or fossils.

A few hundred yards to the north (just across the road) the Brickearth is said to end. On brow of hill London Clay, with a few pebbles at top.

Tylor states that at Church Street, Stoke Newington, the lower sands were 20 feet thick in places.

Sept. 15, 1848.—Mr. Wetherell showed me a specimen of rolled *Astræa*, 2 inches over (Carboniferous Limestone), from the gravel at Whetstone gravel-pits. Also a trilobite from Muswell Hill.

Great Northern Railway, Wood Green cutting (south of Bounds Green cutting) showed :—

	Feet.
Tertiary flint-pebbles in sand	3
Stratified white and yellow sands, no fossils	15
Subangular flint-gravel and Tertiary flint-pebbles, with beds of sand	4
London Clay—Fine brown clay	2
Dark or black clay with very small (1 to 2 inches) Septaria	

May 29, 1855.—The swallow-holes at North Mims are in a field. The water rises in this field sometimes 12 to 15 feet, and sinks there slowly through the several holes, which are not deep, and sided with silt. The water comes up again beyond the church.

[See also Whitaker, "Geology of London," vol. i, p. 203.]

March 3, 1850.—Hitchin. The sand and gravel of the hills around the town appear to be the drift above the Boulder-clay.

It is disposed very irregularly. In [some] places the Chalk rises to the highest levels. In others the sands and gravel form the hill-tops.

Sept. 14, 1851.—[Visit to Bushey, near Watford, and Aldenham.] Gravel caps the whole of this (three-quarters of a mile north-east of the Blackbirds Farm) and the adjacent hills. A fine section of it is shown by the side of the lane half-way between Newlands and Batlers Green. I could find no trace on this hill of the Puddingstone pit formerly worked—or rather, it seems, now worked out; only the overlying gravel now remains.

1855.—Victoria Docks:—

	Feet.
Soil	1
Stiff bluish-grey clay	7
Peat with trees and fresh-water shells	11
Black clay passing into white	[about 2]
Gravel (washed)	

A large flat bone (? whale), 2 feet by 2 feet, was found at a depth of 16 feet in the peat. A grindstone was also found. A lead shield was found at a depth of about 16 feet. Antlers were also found at about the same depth. Urns with [human] bones were also found (apparently British) on the peat. Some of the bones were coated with phosphate of iron.

[See also Whitaker, "Geology of London," vol. i, p. 461; vol. ii, p. 284.]

September, 1847.—Section of Mr. Meeson's pit, Grays Thurrock:—

	Feet.
a. Surface soil ... ... } *b.* Yellow sands with irregular seams of gravel ... ... }	12 to 20
c. Grey and yellow loam with a few pebbles: contains some mammalian remains and a few *Unios*, etc.	3 to 6
d. Subangular flint-gravel	0 to 1
e. Fine yellow sand with numerous bones and fresh-water shells, some masses of wood, and blocks of stone	2 to 6
f. Roughly laminated yellow clay with a few shells and some lignite and seams of sharp white drift sand with shells...	6 to 8
g. Finely laminated grey clay with, in places, numerous impressions and traces of plants, and shells mostly in fragments	5 to 6
h. Ash-coloured and ochreous gravel and loam with numerous shells	2 to 3
i. Laminated ash-coloured and yellow loams with *Unio* and other shells	2 to 4
j. Coarse ferruginous subangular flint-gravel with white and black veins	1 to 4
Soft yellow Chalk, surface irregular	

All the beds are very irregular, and while *b* to *i* thin out towards the Thames, *j* expands to a thickness of 10 to 12 feet. The shells are very numerous, including the *Cyrena* [*Corbicula*] *fluminalis*. In *e* boulders of Tertiary sandstone [greywethers] are occasionally found. One was a broken concretionary mass with the edges rounded off. It was in the midst of brittle and perfect shells, and was about 1½ feet in largest diameter.

[This appears to contain fuller particulars of the strata than elsewhere published. See references by B. B. Woodward, Proc. Geol. Assoc., vol. xi, p. 364.]

June 27, 1852.—By boat to Grays. . . . . Chadwell church stands on gravel over Thanet Sands, which show in the lane below. In a pit at the bottom of this lane and overlooking the marshes the T. Sands are 15 to 20 feet thick, and abound in oviform-shaped bodies (eggs of Molluscs?). Between Chadwell church and Gun Hill the gravel is very ferruginous and worked in many places. It consists chiefly of rounded Tertiary flint-pebbles, not often broken, some subangular flints, a few quartz pebbles, and subangular pebbles of sandstone or imperfect chert (Greensand?). It caps Gun Hill.

1852.—To Stoke Newington. Confirmed the fact of an overlie of irregular gravel over a roughly stratified one throughout the district between the Kingsland Station and Tylor's House [in Paradise Row]. The general section is thus :—

Brown clayey irregular gravel, chiefly B. [Black Tertiary] pebbles and some blocks of sandstone.

Roughly-bedded light yellow-whitish and ferruginous sand and gravel, with mammalian remains.

Oct. 29, 1853.—Braintree. In the drift 1½ [mile] from Wethersfield on the (Nashes Green) Braintree road, a mass of micaceous sandstone was found in a field, the dimensions of which could not be ascertained. The portion exposed measured about 10 to 12 feet across and no edge exposed. A second mass was found in a field ¼ mile north of Wethersfield. It was a grey limestone, 10 feet were exposed and no edge seen.

September, 1849.—Through Bergholt to Stutton. . . . . Beyond Stutton, by the side of the river and forming the base of one of the hills, is the clay-pit in which the bones of Mammalia and shells have been noticed by Mr. Wood :—

	Feet.
Brown clay and flints [coating surface]	2 to 3
Thin-bedded brown clay, appears like London Clay (no fossils)	10
Semi-stone [band]	
Bluish clayey sand ... { Passes to south-west into Light ash-coloured brickearth { light yellow sand }	6 to 8
Very dark tile-clay with remains of plants	2 to 3
Sand, not exposed and depth not proved	20 ?

The bones were said to have been found in the lowest part of the section.

[See Whitaker, "Geology of the Country around Ipswich, etc.": Mem. Geol. Survey, p. 95.]

1859.—Stutton. The fresh-water deposit commences about half a mile east of Stutton Mill in a low cliff, first of gravel, then of London Clay, and then fresh-water deposit. This then continues for about half a mile, being in part formed of reconstructed gravel and London Clay :—

	Feet.
Brown clay with gravel in places, no shells...	4
Light marl	1
Gravel and sand	1
Light-coloured clay with gravel and perfect shells	4
Coarse gravel and clay	1

There are few shells at first, but further on the *Cyrena* becomes abundant with several large *Unios*. The common shell is the *Cyclas* or *Pisidium*, then the *Bythinia*. Only a few *Planorbis*. The Cyrena usually in single shells and in all positions; a few double.

1864.—The watershed of the Waveney and Ouse is at Lopham Ford. The valley there is as important as elsewhere, and a bed of high-level valley-gravel occurs at least 30 feet above the valley, close to the watershed. There is no dividing ridge; a peaty marsh fills the bottom of the valley, and the Waveney flows out of it. A bed a few [feet] high of sand and gravel rises to level of peat, and this seems to form the division of the two streams. Trees and numerous bones (skeleton of deer) are found in the peat.

[See also Rev. O. Fisher, GEOL. MAG., vol. v, p. 557; and F. J. Bennett, "Geology of the Country around Diss, etc." : Geol. Survey, p. 16.]

2. WESTERN COUNTIES.

July 18, 1878.—To Wantage with Morris. . . . . Thence through East Challow, where the Hippopotamus is said to have been found. The pit is no longer worked, but appears to have been a shallow Gault pit. The H. tusk in possession of Mr. [E. C.] Davey looks very fresh, as though out of a peat.

July 14, 1857 (6 p.m.).—Chippenham. Walked out to Kellaways. . . . . Found a small pit in a field by Avon Farm :—

	ft.	in.
Brown clay	1	6
White small gravel	3	0
Clay		

The brown clay contains only a few pebbles, and would not lead one to suspect the presence of gravel. The gravel consists of small, flat, worn fragments or pebbles of the local oolitic rocks—some of the harder ones in subangular pieces, and fragments of angular flint (both direct from Chalk, but more from the ferruginous drift on the Downs). The matrix is sand. Saw no bones or shells.

[See also H. B. Woodward, Proc. Geol. Assoc., vol. xiv, p. 341.]

July 15, 1857.—Devizes. Section at Broughton, near Melksham :—

	Feet.
Brown clayey sand with few pebbles	3 to 4
White gravel with irregular thin beds of sand ...	4 to 5
Oxford Clay	

Brown subangular flint from old gravel. Angular black and white chalk flints. A few quartz and lydian-stone pebbles—Lower Greensand. [Stones, septarian fragments, etc., from] Oxford Clay and Kellaways Rock—abundant, chief mass. Forest Marble. All the mass is in small pieces, rounded and flattened, worn, except the flints, which are sharp and nearly unworn. This gravel rises 10 to 20 feet above the river-level, ranges to Broughton Church and Holt on the west of the river. A small peat-bed overlies the gravel (replacing the brickearth) by the river. The gravel is all derived from material to the north-west.

Mr. Wilkinson, the vicar of Broughton, accompanied us. He stated that the tusk of an elephant (now in the Bath Museum, presented by Mr. Macneill) was found in the gravel on the line by Broughton.

[See also R. N. Mantell, Quart. Journ. Geol. Soc., vol. vi, p. 313.]

July, 1857.—To Warminster. Stopped at Codford Station. Up the valley to Chittern [east of Heytesbury] . . . . slope of hills bare. Top covered with flints 1 to 2 feet deep in an earthy-coloured sand and clay, occasionally also small white quartz pebbles. At the clump on top of Clay-pit hill sand and clay have been dug. The section is much obscured, traces of mottled clay, yellow and white sands, a carbonaceous bed, concretions of ironstone. Small masses of a soft white sandstone (?) were, however, strewn about, and led me to believe that the Tertiary beds were *in sitû*, and protected by being in a large sand-pipe. In one hole, however, the section was clear :—

White gravel	2 to 10 feet.
White siliceous sand	10 feet.

The gravel consists of perfectly rolled (although some broken), largish pebbles of white-coated flints, very light, of a few small black flint-pebbles in a white and light yellow coarse sand, full of small white quartz pebbles, with a few quartz and black slate (?) pebbles, all spread confusedly over the white sand into which they penetrate but with which they do not mix. They appear to be a Tertiary bed either remanié or drifted.

The white sand is very fine, pure, and white, just the stuff that when solidified would form the Druid Sandstone.

The order of superposition appeared to be :—

Yellow clayey and sandy drift, full of quite angular yellow flints and small quartz pebbles ...	1 to 2 feet.
White flint pebbles and quartz pebbles	6 feet.
White sand Carbonaceous clay Mottled clay	10 feet.

The flint drift continues to Oldbury Camp.

[In his paper on Westleton Beds, Part II, Quart. Journ. Geol. Soc., vol. xlvi, p. 144, Sir J. Prestwich refers to "a large Tertiary remnant" on the Chalk Downs of Copford (Codford), east of Warminster, and remarks that it has been preserved from denudation by having been let down into a cavity in the Chalk.]

October, 1848.—Marlborough. [Notes the occurrence of ochreous clay and flints which rest on a "piped" surface of Chalk.] The flints are large and unrolled. The clays appear to consist of the breaking up of the mottled clays and sands, the action not long continued. In some places the clay is free from flints. In others they occur piled one on another as close as they can be packed.

No Date.—Calne. Surface of Chalk, top of Monument Hill. It is drilled in places with Serpula-like cavities, 2 to 3 inches in length, but more irregular in form ; made by the action of water and the roots of grasses ? Some of the latter still remain in the tubes.

Mendips, Drift on top of. It consists of a bright red clay, with flint-pebbles (small Tertiary) and angular fragments of flint (chalk ?).

[See also Prestwich, Quart. Journ. Geol. Soc., vol. xlvi, p. 143.]

Sept. 19, 1849.—Sarum. See gravel on Alderbury Hill, said to [be] different and better than any for 20 miles around.

The gravel at the abandoned Andover railway consists almost entirely of some large but mostly small angular white flint-pebbles, with 2 or 3 per cent. of black pebbles (some broken) and traces of sandstone in bits, embedded in brickearth, this latter sometimes pure, at other places the gravel being all of a mass and loose. Below this is a chalk-rubble of Chalk and a few angular flints, and with many small white flat pebbles. The general section of these valleys would be thus [diagram showing Alderbury Hill as Hill gravel]. All the valleys in the district, such as the valley of the Romsey river and that of the Southampton and Winchester rivers, appear gorged with gravel. Also in the valley at Dean, where it is underlaid by a chalk-rubble.

[In his paper on the Westleton Beds, Part III, Quart. Journ. Geol. Soc., vol. xlvi, pp. 176, 181, Sir J. Prestwich is inclined to regard the Alderbury gravel as an outlier of Westleton Shingle. Eolithic implements have been found in the Alderbury gravel by Dr. H. P. Blackmore.]

December, 1845.—Section at Studland.

[Base of Bagshot Beds.]	Light-coloured laminated grey and brownish clay.
	Light-coloured sands.
[London Clay, etc.]	Gap, section hidden, apparently clays.
[Reading Beds.]	Fine white sand, 2 to 3 feet?
	Bull-head flints, consisting of a conglomerate of large angular flints, small flint pebbles, and small quartz pebbles, in greenish clay and compact iron-sandstone.
	Chalk.

[The Lower Eocene strata at this locality have not been described in detail owing to the general obscurity of the coast-section. See also J. S. Gardner, Quart. Journ. Geol. Soc., vol. xxxix, p. 208; C. Reid, ibid., vol. lii, p. 490.]

No Date.—Section on the Chalk hill above the tunnel on the Dorchester and Weymouth Railway :—

Irregular mass of rolled white flint-pebbles, some of a very large size (1 foot in diameter), and angular flints with the edges abraded.

Irregular mass of yellow sand, layers of gravel (roughly stratified) as above, but finer, and white pipe-clay full of grains of quartz; quartz pebbles abound in the gravels. The flints are generally white all through, a few only are black in and out.

The line of separation [between the gravels] is very uncertain.

[Total thickness marked 50 feet. Bedding approximately horizontal.]

[See also Prestwich, Quart. Journ. Geol. Soc., vol. xxxi, pp. 40, 41; O. Fisher, Geol. Mag., 1896, p. 246; A. Strahan, ibid., p. 334; C. Reid, Quart. Journ. Geol. Soc., vol. lii, p. 494.]

N. D.—Crewkerne, Drift on Chalk hill one mile south of. Green clay with black portions, and angular fragments of flint coated black, passing into a fine breccia of very small fragments of Chalk in the green clay?

Fragments of Inocerami, hard, not effervescing, in red clay from gravel on the hill $1\frac{1}{2}$ mile north-east of Crewkerne. [Composition of gravel :—]

1 pebble soft ragstone.
2 subangular fragments of decomposed white flint.
1 angular fragment of flint unaltered.
1 angular pebble of grey quartzite.
2 subangular fragments of white veined quartz.
1 subangular fragment of hornstone.
1 rough pebble of compact slate.
1 subangular fragment of iron-sandstone.
1 piece of ironstone with white quartz pebbles.
W.? [= Westleton Beds?].

[See Prestwich, on Westleton Beds, Part III, Quart. Journ. Geol. Soc., vol. xlvi, p. 162.]

1852.—Sidmouth. The hills to the west are capped by a mass of broken flints in yellow clay and sand; they are *perfectly* sharp and associated with a mass of small sharp fragments; sometimes the clay is ochreous and slightly ferruginous. The whole is confusedly heaped together. In places there is hardly anything but the clean sharp flints, no matrix. A few subangular pieces of iron-sandstone occur in the gravel.

Large blocks consisting of a hard light-drab or white siliceous limestone paste, embedding sharply angular flints and fragments of flints, occur also in the gravel; some of the blocks are 4 to 5 feet in diameter, some of them are mere small hand-pieces. A gravel covers slightly the slopes of the hills, and is accumulated thickly in the valleys. The same flint-gravel caps the hills around Lyme Regis.

[A section at the railway cutting, Newton Bushel (Newton Abbot), was noted in April, 1847. This was represented roughly in diagram as showing:—]

Gravel and sand irregularly overlying a series of inclined beds as follows:—
Red clays and lumps of limestone.
Coarse sands and gravels, white quartz sands, chert nodules, black angular pebbles.
Fine white clay and sandy clay.
Coarse white sands and fine gravel.
Red clay passing into light clay with lumps of carb. wood [lignite].
Coarse sands, as above.

[See also Prestwich, Quart. Journ. Geol. Soc., vol. xlviii, p. 318; H. B. Woodward, ibid., vol. xxxii, p. 230; Ussher, ibid., vol. xxxiv, p. 448; C. Reid, ibid., vol. liv, p. 234; A. E. Salter, Proc. Geol. Assoc., vol. xv, p. 282; D. Mackintosh, Geol. Mag., 1867, p. 392.]

Easter excursion, April, 1867.—J. P. [Prestwich], Godwin-Austen, Gwyn Jeffreys, and Captain Galton joined at Plymouth by Spence Bate.

To Newton Bushel, upper gravels of Bovey Tracey, large and coarse, mostly quartz pebbles. They seem to be about 50 feet above level of river. Portion of Bovey Tracey Beds rises out from them.

Beyond Bovey Tracey the rocks are bare, but descending to the river at Woolford [Wilford] bridge we found ledges of a gravel terrace fringing the valley at a height of about 25 feet above river. It contained largish blocks of rolled granite, no scratched pebbles, and is about 4 to 6 feet thick. At one place it is overlaid by imperfect loess and angular débris.

At Willoway [about one mile south of Wray Barton] the river-banks show the lower gravel (about 5 to 6 feet above stream) more worn and generally finer, but with more numerous blocks of granite.

3. Midland and Northern Counties and Wales.

1851.—Cutting at Winslow on L. & N.W. Railway to Oxford shows:—

Coarse gravel [about 2 feet]	12 feet.
Blue Boulder-clay [about 8 feet]	
Light-coloured gravel [about 2 feet]	

Aug. 10, 1856.—Cock Hotel, Stony Stratford. Oolite quarry near Cosgrove:—

	Feet.
a. Earth and worn fragments of oolite, with a few angular flints and New Red Sandstone pebbles	2
b. Oolitic flags, broken at top	2
c. Oolitic marl	6
d. Oolite in thick beds—bluish	

Pupa and a small *Helix* are found in *a*, but may have been washed in. This bed covers the oolite down to the canal, same thickness all the way. The top of this pit appears to be only about 20 to 30 feet above the river.

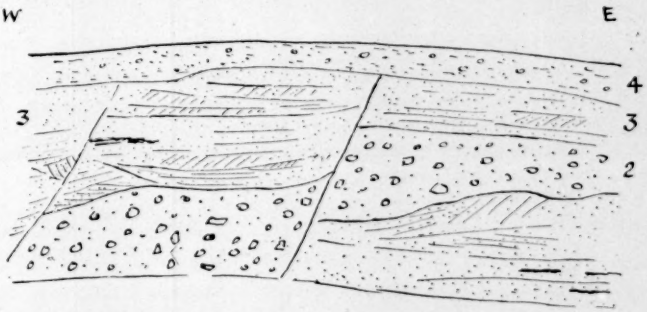
Descending the hill, and on another low hill on same level as the oolite, is a gravel and sand pit. The sands are composed of oolitic and quartz grains, with a few oolitic and quartz pebbles, flint fragments, full of false stratification. No shells.

The coarse gravel is composed of:—

Large coarse pebbles and worn fragments of hard oolitic beds—some blocks 1 foot in diameter.
Hard chalk.
Subangular flints, brown from gravel and white from Chalk.
Clay and shale nodules, Lias and Oolite.
Small ironstone fragments.
Quartz pebbles, a few large.
A few grey and reddish siliceous sandstone pebbles, but not numerous—no supply, or a very small one, from New Red Sandstone.
A few pebbles of slate and old rocks.

Fossils of the oolites are numerous. They are not much worn. In the upper soil are a few New Red Sandstone pebbles.

1856.—Pit just above valley at the foot of Cosgrove Hill.



4. Surface drift and earth, local, and New Red Sandstone pebbles.	About 17 feet.
1 and 3. Sand with false lamination, coaly bands.	
2. Very coarse gravel—some blocks 1 ft. in diam.: 4 to 8 ft.	

Fault with downthrow of about 5 feet in centre of section.

Feb. 24, 1859.—Northampton to Stamford. Mr. Bentley informed me that just above the town [Stamford], in some large stone-pits, a great fissure 20 feet deep and closed in at top was exposed by the workings. The bottom was covered by a light-coloured clay or loam, in which many bones were found, white and well preserved. He had kept only a few: among them is a small plate of an elephant's tooth, teeth of deer, of hyæna, and bear?

[With the exception of bear the occurrence of these animal remains was confirmed by S. Sharp, Quart. Journ. Geol. Soc., vol. xxix, p. 254.]

Mr. Bentley directed my attention to the drift near Saxby and Melton Mowbray, where great beds of sand and gravel, disturbed by faults, underlie the Boulder-clay, not disturbed.

Aug. 29, 1859.—Hill S.E. of Pershore; bare clay on slope, gravel on top. Same on next hill nearer Cropthorne and at Cropthorne itself. There it is more sandy, almost all sand derived from the New Red Sandstone. This gravel is 4 to 8 feet thick, not stratified, no oolitic débris, almost all N. R. S. débris and a few flints.

Beyond Cropthorne, in a low hill, is another gravel with oolitic débris. Returning through Cropthorne to the new pit at New Inn, [section showed:—]

	Feet.
Brickearth [resting irregularly on]	2 to 3
Gravel of N. R. S débris with angulite oolitic débris in small quantities and a few flints	1
Brickearth with *Cyclas*, *Succinea*, etc.	2
Brown solid gravel with *Succinea* (perfect, 5 feet from top), also a small *Helix*. More sandy at base, fragments of bones	9

This is on rather a lower level than Cropthorne.

Mr. Strickland's old pits are all filled up. The section, I was informed by Charles Price, consisted of:—

	Feet.
Brickearth	18
Gravel, bones at top	4
Sand with shells	2
Brown clay	

A few bones were also found in the brickearth, but not so perfect.

[See W. C. Lucy, Proc. Cotteswold Club, vol. v, p. 85.]

No Date.—Criccieth [Carnarvonshire]. Boulder-clay gravel. The grey matrix of this gravel consists entirely of fine small flat grains, much worn, of shales and slates, varying in size from a grain of sand to a threepenny piece.

Nov. 23, 1859.—Accompanied Mr. Denny and Mr. Teale to Wortley [Leeds]. Section in the town near the Square showed:—

	Feet.
Made ground	4
Sandy beds	2
Yellow clay	1 to 2
Blue clay	1

The workmen said this last was 10 to 12 feet thick, and reposed on the solid rock. At Wortley the pits are almost obliterated. The

ground is but little above the level of the river and at the foot of slight slope down from the jail. The beds seemed to me to be blue clay with traces of rootlets, with the upper surface decomposed to a bright yellow and 5 to 6 feet thick. In places the Coal-measure rocks showed beneath the clay. The Hippopotamus remains, Mr. Denny said, were found deeper down (10 to 12 feet) in a more sludgy and peaty matter. They were solid and dark-coloured and entire. The elephant and ox remains were rather higher up, more broken and worn. . . . . The remains of the Hippopotamus are the finest I have seen: there is nearly an entire skeleton.

[See H. Denny, Proc. Geol. and Polyt. Soc., W. Riding, for 1853, 1854, p. 325; and T. P. Teale, Rep. Brit. Assoc. for 1858, Sections, p. 111.]

March 4, 1859.—Newcastle. Approaching Shields the Boulder-clay seems to become thinner. It is in fact deposited on a lower [level], for at Jarrow dock it passes under[1] the bed of the river and is overlaid by 50 feet + of silt, the upper part of which contains thin seams of gravel, and the whole of which abounds in perfect and double estuarine shells such as now inhabit the river; also with traces of wood and a few trunks of trees, and hard lumpy nodules of grey angular limestone enclosing recent shells and beautiful impressions of recent leaves, looking altogether more like nodules and fossils of far older date. Pieces of branches of trees are also found fossilized, more or less in the centre. In one specimen of birch stem the outer bark or peel alone remains unaltered, the inner bark was quite petrified and seemed to possess structure. Crystals of Gay-Lussite [hydrated carbonate of lime and soda] occur commonly in the centre of the nodules.[2] Altogether it is a very curious and interesting recent deposit.

Bones and entire skeletons of the red deer have been found at the base of the deposit near its edge and on top of the Boulder-clay. The nodules are found low down in the silt and up to within 5 feet of surface. Mr. Howse thinks the chemical works may have had something to do with them. He said some of the blocks were as large as a large stool.

[See also Richard Howse, Trans. Tyneside Nat. Field Club, vol. v, pp. 117, 118, and Trans. N. Eng. Inst. Engineers, vol. xiii, p. 169.]

NOTICES OF MEMOIRS.

The Pelican as an Indigenous British Bird. On some Bones of a Pelican from the Cambridgeshire Fens.[3] By Sidney F. Harmer, M.A., B.Sc.

In February, 1897, some bones from the Fens were brought to the University Museum of Zoology at Cambridge. Most of these specimens belonged to the Beaver, Pig, Swan, Goose, and

[1] In a later note the writer says: "It seemed to me almost to pass under it."

[2] [A mineral described under the name of 'Jarrowite' by E. J. J. Browell was obtained from Jarrow Slake. It consists of carbonate of lime with nearly 4 per cent. of carbonate of magnesia.—Trans. Tyneside Nat. Field Club, vol. v, p. 103.]

[3] Reprinted from the Transactions of the Norfolk and Norwich Naturalists' Society, vol. vi (1897).

Pike; but three of them proved, on examination, to have belonged to a Pelican, a bird which has been recorded on two previous occasions from the same part of the country.

The first account was given by Professor Newton (Proc. Zool. Soc., 1868, p. 2), and refers to a left humerus, in the Woodwardian Museum at Cambridge. This specimen was described by Professor Alphonse Milne Edwards in the *Annales des Sciences Naturelles* (5e sér., Zool., vol. viii, 1867, p. 285); and a translation of this paper appeared in *The Ibis* (N.S., vol. iv, 1868, p. 363). Milne Edwards described in detail the characters by which the humerus of a Pelican can be distinguished, the great size of the bone being alone an almost certain indication of the genus. He further pointed out that the ossification of the specimen submitted to him was incomplete at the articular extremities; and that the bird was therefore a young one, which was probably native to the Fens, and not an accidental immigrant.

A second left humerus from Feltwell Fen, in Norfolk, was presented in 1871 to the University Museum of Zoology by Mr. J. H. Gurney, jun., to whom it was given by Mr. John Baker, the well-known Cambridge birdstuffer. In exhibiting it to the Zoological Society, Professor Newton called attention (Proc. Zool. Soc., 1871, p. 702) to its correspondence in size with the humerus of a recent specimen believed to belong to *Pelecanus crispus*.

The bones which have recently been acquired by the University Museum of Zoology were found at Littleport, near Ely. They were formerly in the possession of James L. Luddington, Esq., who has been kind enough to inform me that they were found on his farm in Burnt Fen, Littleport, some seven or eight years ago. They consist of the lower end of a humerus and the upper ends of a radius and ulna, all of the left side, and appearing to belong to the same individual. The conclusion that these are the associated bones of a single specimen is quite in accordance with previous experience of the way in which the bones of various animals are found in the peat of the Fens.

The humerus of the Littleport specimen agrees closely with the Feltwell bone, and the three Littleport bones have the closest resemblance, in form and size, to the corresponding bones of the recent *P. crispus*, to which reference has already been made. The ulna is, however, abnormal at a distance of 11 or 12 cm. from its upper or proximal end, and it has the appearance of having been broken, although the fracture was repaired during the life of the bird. The part of the ulna which is preserved measures only 15 cm., so that the whole of the injured region of the bone is not visible. The resemblance, in other respects, between the Littleport bones and those of the recent *P. crispus* certainly lends support to the view hinted at by Professor Newton in 1871, and repeated on page 703 of his "Dictionary of Birds" (part iii, 1894), that the Fen specimens belonged to that species.

It is worthy of remark that a left humerus has been found on each of the three occasions on which the remains of a Pelican have

been recorded from the Fens. The evidence thus afforded of the occurrence of three individuals goes far in support of the view that the Pelican was really native to this part of England.

REVIEWS.

I.—Wachsmuth and Springer's Monograph on Crinoids.[1]

Third Notice.

THE fundamental plates in a crinoid cup are the five *radialia*. Oddly enough they are the last of the calycal plates to appear in the development of *Antedon*, and yet they are the very elements in whose constancy and regularity lies the difference between the Crinoidea and their Cystidean ancestors. Intimately correlated as they are with those characteristic crinoid structures, the *brachia* or arms, they are the sole permanent elements of the cup. Other parts may be added to or taken away from, but the radialia, or 'radials' *par excellence*, always remain.

The radials, I have said, are five; that is, one in each ray. In old days other plates that happened in some genera to be incorporated in the cup along the lines of the radii were called radials; but such plates are now understood to have been primitively arm-ossicles, and are therefore known as fixed brachials. The recognition of these facts, due to Wachsmuth & Springer and P. H. Carpenter, has enormously simplified the task of description, and has for ever closed the wearisome discussions as to where the arms began in the various genera.

It must not, however, be supposed that the facts are quite so simple as might appear from the above statement. As our authors express it: "In the earlier Inadunata and Articulata—not in the Camerata so far as observed—the radials are frequently compound, i.e. constructed of two segments or parts, which are closely united by a horizontal suture, and in the organization of the Crinoid count as one plate." For the two halves of such a compound radial Wachsmuth and Springer adopt the terms *superradial* and *inferradial*, proposed by me in January, 1892. The latter term is certainly superior to 'sub-radial,' used by Jaekel in 1895 for the same element, since not only does sub-radial mean a plate below the radial, but it was actually applied to such plates, viz., the basals, for many years by some authors.

The mutual relations of inferradials and radials, and the varying number of compound radials in the several genera of Inadunate Crinoids, lead our authors, by steps which I do not follow, to the conclusion "that there was a time in the early history of the Crinoids when the arm-bearing section [the superradial] was altogether unrepresented. This was apparently the case in

[1] The North American Crinoidea Camerata. By C. Wachsmuth and F. Springer. Mem. Mus. Comp. Zool. Harvard, vols. xx and xxi, containing 838 pp. and 83 plates. (Cambridge, U.S.A., May, 1897.) For First and Second Notices, see June and July Numbers.

Baerocrinus, in which two of the radial plates are non-armbearing, and as these plates occur in the same rays as the compound plates of *Anomalocrinus*, we may infer that *Baerocrinus* is the ancestral form, lower in its development than either *Anomalocrinus*, *Hoplocrinus*, or *Iocrinus*." Sad experience prevents me from attempting any interpretation of Wachsmuth and Springer's views on this difficult genus *Baerocrinus*; it is enough to point out that fresh material has led Professors Fr. von Schmidt and O. Jaekel to the conclusion that it is based on an abnormal form of *Hoplocrinus*.

Apparently Messrs. Wachsmuth and Springer regard the presence of inferradials as a primitive character. They do not, however, accept the statement published by me in 1893, that "a very large number of Inadunata Monocyclica closely resemble one another, either in the horizontal bisection of certain radials, a character which in Dicyclica is entirely confined to the right posterior radial, or in the greater development of certain other radials."[1] These facts appeared to me to confirm the separation of monocyclic from dicyclic forms. The justice of this conclusion may be debated; but as to the facts there should be no question, and I regret to find the above statement seriously objected to by the learned Americans.

First let us examine their remarks on the compound radials. As to their presence in Dicyclica, setting aside the right posterior radial, they say, "He overlooks the dicyclic *Tribrachiocrinus*, which has three compound radials." This statement does not agree with Wachsmuth and Springer's own diagnosis ("Revision of Palæocrinoidea," iii, p. 251), or with their remark in the present Monograph (p. 72) that "the later Fistulata have no true compound radials"; nor, as is more important, does it agree with the full descriptions by Mr. R. Etheridge, jun. (1892), abstracted in the GEOL. MAG., Dec. III, Vol. X, p. 82, descriptions which the courtesy of Mr. Etheridge and others enabled me to verify in person when at Sydney. Supposing it to be the case that two radials of *Tribrachiocrinus* have fused with the first primibrachs, this does not make them horizontally bisected. Messrs. Wachsmuth and Springer write as though it made no difference whether one got a half-crown or two shillings in change for a florin.

Next our authors say that among the twenty-four genera which I referred to the Monocyclica "only eight have three compound radials," "there are three with two compound radials, *Anomalocrinus*, *Ohiocrinus*, and *Baerocrinus*, and three with a single one; the remaining ten genera have simple radials throughout." Even were these statements correct, the group Monocyclica would have 58.3 per cent. of its genera with compound radials, as opposed to a problematical 1 per cent. in Dicyclica. Such a fact cannot be "seriously in the way of making the presence or absence of infrabasals a subordinal character." But the statements neither were nor are correct. *Ohiocrinus*, for instance, is here said to have but two compound radials; but in the same authors' "Revision" (pt. iii, p. 208) it was said to have "the plates of the calyx

[1] "Crinoidea of Gotland, I," p. 20: *Svenska Vet-Akad. Handl.*, XXV, No. 2.

arranged as in *Stenocrinus*," which is now called *Heterocrinus*, and has three compound radials. *Anomalocrinus* also was formerly described by Wachsmuth and Springer (Revision, iii, p. 211) as having two or three compound radials, the "left postero-lateral" being "either simple or bisected vertically." They subsequently figured it with no less than four compound radials,[1] a figure that also conflicts with their present statement that at least two of the radials in every crinoid are always simple (p. 71). Even more unwarranted is their next remark: "Neither do we find [in Monocyclica] any remarkable development of certain radials, except when these are compound." The large left posterior and anterior radials of *Pisocrinus*, *Triacrinus*, and *Haplocrinus* are not compound, but their modification is undoubted, and similar enlargement is very remarkable indeed in the Calceocrinidæ and in *Mycocrinus* and *Catillocrinus*.

But if they will not admit these facts in Monocyclica, my critics try to maintain that they do occur in Dicyclica. "Bather," they continue, "claims that among the Dicyclica departures from the pentamerous symmetry of the cup plates occur only in the right posterior radial. [When and where I made this preposterous claim is not stated. I said, "horizontal bisection" occurred only in r. post. R.] Exceptions to this, however, are found in *Atelestocrinus* and *Nanocrinus*, in which the symmetry is disturbed by the anterior radial, and in the latter genus by the right antero-lateral together with the anterior." This is a curious way of expressing the fact that in those genera the anterior radial is smaller than the others and bears no arm, a fact which is not in either of the categories under discussion.

But enough of controversy! Let me state what I now believe to be the facts of the case. Thirty-one genera may be referred to the Monocyclica Inadunata. Of these, twenty diverge from the normal symmetry to a greater extent than by the introduction of anals, viz., ten[2] through the horizontal bisection of certain radials other than the right posterior (usually the right and left anterior radials), while the remaining radials often increase in width; eight[3] through such increase in width of certain radials (usually l. post. R. and ant. R.), often accompanied by a variation in the number of arms directly springing from the radials; one[4] by disappearance of a radial (an occurrence also found in some of the other genera[5]) and apparent increase in the number of arms springing from the radials (as in some other genera[6]). The proportion of forms asymmetrical in the manner described would be larger if only Palæozoic genera

[1] "Perisomic Plates": *Proc. Acad. Nat. Sci. Philadelphia*, 1890, pl. x, fig. 10.

[2] *Heterocrinus*, *Ectenocrinus*, *Ohiocrinus*, *Anomalocrinus*, *Herpetocrinus*, *Castocrinus*, *Euchirocrinus*, *Calceocrinus*, *Halysiocrinus*, *Haplocrinus*, and perhaps *Phimocrinus*.

[3] *Hybocystis*, *Hoplocrinus*, *Pisocrinus*, *Triacrinus*, *Calycanthocrinus*, *Mycocrinus*, *Catillocrinus*, and *Allagecrinus*.

[4] *Zophocrinus*.

[5] e.g. *Tetracrinus*, and probably *Herpetocrinus*.

[6] e.g. *Catillocrinus*, *Mycocrinus*.

were dealt with, to wit, 75 per cent. No amount of ingenuity could discover a proportion anything like this among Dicyclica Inadunata. I therefore affirm "the extreme importance of these points" with far greater confidence than in 1893, a confidence strengthened by the nature of the criticism hitherto passed on my views.

That part of the dorsal cup below the radials may consist of either one or two circlets of plates. The plates next below the radials are called *basalia*; they alternate with the radials, i.e. each basal is interradial in position. The plates that may occur below these are called *infrabasalia*, and are radial in position. When there are basals only, the base is said to be monocyclic; when there are also infrabasals, it is dicyclic. A monocyclic form with inferradials may appear to have a cup composed of three circlets; but these cannot be confused with the three circlets of a dicyclic form, since inferradials do not alternate with radials proper as do basals. Occasionally, it is true, the radials appear a little shifted to one side, and it seems as though a continuance of such shifting might render the inferradials indistinguishable from basals. Thus Dicyclica might be derived from Monocyclica. A very obvious objection to this view lies in the coexistence of basals with a radianal in many Dicyclica, for the radianal is generally admitted to be nothing other than the right posterior inferradial. That difficulty could be overcome by denying the accepted homology; but there remains a more fundamental objection, which will be understood from comparison of figures D and M in Fig. 1:—

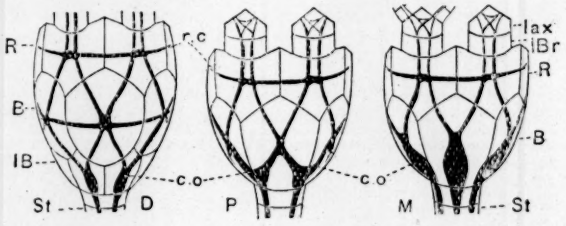


Fig. 1.—Course of axial nerve-cords in Dicyclic (D), Pseudomonocyclic (P), and Monocyclic (M) Crinoids.

These show the course of the axial nerve-cords in a dicyclic and monocyclic form respectively. It will be seen that these cords, on their passage from the nerve-centre called the chambered organ (c.o.) to the arms, bear a definite relation to the plates of the cup. If this relation held good in early Palæozoic crinoids, as we have reason to suppose, then I find it impossible to conceive of any shifting of the lower part of R in Fig. M that should produce such an arrangement as that shown in R and B of Fig. D. Therefore I reject the hypothesis of the derivation of Dicyclica from Monocyclica. That hypothesis is not discussed by Wachsmuth and Springer; in fact, they refuse to consider a somewhat similar

suggestion of Dr. J. Walther's. It is here alluded to with the view of emphasizing the fundamental distinction between Monocyclic and Dicyclic crinoids.

Another hypothesis—the descent of Monocyclica from Dicyclica—stands on a different footing. No one has done more than Wachsmuth and Springer to point out that the infrabasals often diminish in size, become hidden beneath the stem, and may eventually disappear altogether, at least in the adult. At the same time they have insisted on important differences between such forms and those that were without infrabasals from the beginning. To express this conception in nomenclature I proposed the term Pseudo-monocyclica for crinoids with obsolete infrabasals. The differences just alluded to are identical with certain differences that always (or almost always) obtain between Dicyclica and Monocyclica, and have been summarized in the well-known Law of Wachsmuth and Springer. They are diagrammatically represented in Fig. 2:—

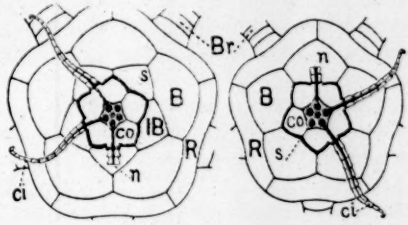


FIG. 2.—Comparison of the dicyclic and monocyclic base. B, basal; Br, brachials marking the five rays; *ci*, cirri, only three out of the five are shown; *co*, pentameres of column; IB, infrabasal; *n*, nerves going to cirri; R, radial; *s*, sutures between pentameres of stem.

The law is given in the Monograph under review in the form of a table (p. 60), and may be stated thus: when infrabasals are, or have been, present, the exterior angles and the pentameres of the stem are interradial (ie. alternating with IBB), but the longitudinal sutures, the sides, the lobes of the axial canal, and the cirri of the stem are radial; in crinoids with a truly monocyclic base these positions are reversed. "This law," its authors observe, "is only applicable, to its full extent, in species with pentangular or pentapartite stem and canal." Unfortunately it is not universally applicable even to those, and although the law as it stands is a remarkable piece of induction from which have been deduced conclusions at first unexpected but subsequently proved, yet it requires placing on a firmer basis before it can be accepted as other than a purely empirical statement liable to random exceptions.

This basis I shall now attempt to furnish. But first let us consider the exceptions. Wachsmuth and Springer say there are two, "and, so far as we know, only two. In *Pentacrinus* [=*Isocrinus*] and the monocyclic *Glyptocrinus Fornshelli*, S. A. Miller, the axial canal has the same orientation as the outer angle of the stem." Other examples could be adduced from the Silurian crinoids of England and Gotland, but those given serve to show

the unreliability of the law as now stated. Wachsmuth and Springer say that the structure in *Pentacrinus* [= *Isocrinus*] "simply points to the existence in some groups of transition forms intermediate between Monocyclica and Dicyclica" (p. 66), and again, the structure in *G. Fornshelli* "proves nothing more than that in this species the monocyclic stage was as yet incompletely developed." At the same time they are not clear whether Monocyclica were derived from Dicyclica, or *vice versâ*, though they favour the former view; also they find it "difficult to explain the change in the orientation of the stem."

Now all these difficulties can be overcome, and the differences between Monocyclica and Dicyclica seen in their true light, if we pay rather less attention to the particular shapes of the ossicles, and rather more to the relations of the axial nerve-cords and the chambered organ. The middle drawing (P) in Fig. 1 shows the relations of the cords in a pseudomonocyclic form. What has taken place is a compression, not a torsion: the orientation of the cords both above and below remains precisely as in Dicyclica and unlike that in Monocyclica. Confirmation of the hypothesis of compression may be obtained by cutting transverse sections across the chambered organ of an admittedly pseudomonocyclic form. Figure 3 is a diagram reconstructed from several such sections of *Pentacrinus* [= *Isocrinus*] as figured by P. H. Carpenter in his "Challenger" Report. We here trace the nerves as they pass out of the radials

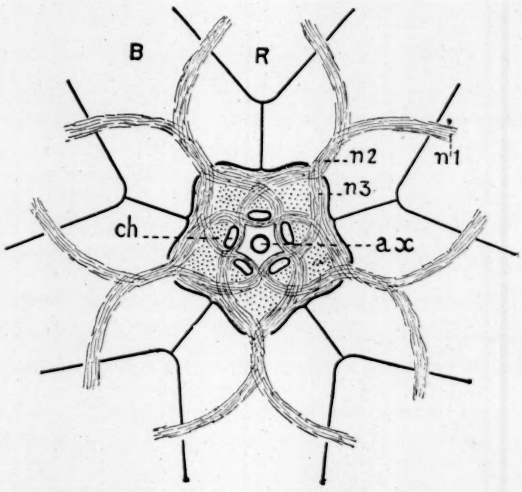


FIG. 3.—The course of the axial nerve-cords in *Isocrinus*.

into the basals (*n* 1), then meeting in the middle of the basals and passing down as interradial cords (*n* 2). Now comes the important point: these cords, instead of passing directly into the capsule of the chambered organ, as in Monocyclica, fork again: the branches (*n* 3)

of the forks meet radially, and then enclose the radially placed chambers of the central organ (*ch*). These, as usual, are disposed around the axial organ (*ax*), and extensions from all of these pass down into the lumen of the stem. Thus, in *Isocrinus* the five nerves and vessels of the stem are, as is well known, radial in position, and give off branches to the radially placed cirri, as becomes a dicyclic or pseudomonocyclic crinoid.

Admitting the prime importance of the chambered organ and its various extensions, we see that the cirri must follow the course of the axial cords from which they are innervated and nourished; we may also imagine that the pentameres of a quinquepartite stem were brought from their original alternating arrangement, into vertical lines, by the extensions of the axial cords, between which they therefore lie. On the other hand, there is nothing in the fundamental constitution of a crinoid to prevent the outer angles of the stem, and by consequence its sides, from assuming any position; and although the angles of the lumen most naturally correspond with the orientations of the axial cord, still secondary formation of stereom may readily cause a change in this respect without upsetting the morphology of the animal. That such secondary formation of stereom does take place is no hypothesis; it has been described in *Antedon* by W. B. Carpenter, H. Bury, and others. In fact, the odd thing about that genus is that the very features on which Wachsmuth and Springer relied in their famous prediction that it would be proved dicyclic, are of purely secondary nature. It is to such secondary stereom that the changes in the lumen of the *Isocrinus* stem may be ascribed. As for *Glyptocrinus Fornshelli*, it is surprising that no figures are given by Wachsmuth and Springer of a structure that leads to so much discussion, but S. A. Miller's description (1874) is certainly suggestive of a similar explanation.

For the table given by Wachsmuth and Springer, I propose therefore to substitute the following, in which the statements liable to exception are marked with *.

	Dicyclic.	Monocyclic.
BB (lobes of capsule in Monocyclica)	Interradial	Interradial
IBB (lobes of capsule in Dicyclica)	Radial	—
Pentameres of stem, when present	Interradial	Radial
*Outer angles of stem	Interradial	Radial
Vertical sutures of stem, when present	Radial	Interradial
*Sides of stem	Radial	Interradial
*Angles of lumen of stem	Radial	Interradial
Cirri, when present	Radial	Interradial
Axial cords of stem	Radial	Interradial

From this it appears that the sole constant characters are those presented by the aboral nerve-system, characters which find no place in Wachsmuth and Springer's statement. Thus, I believe, the law first discovered by these eminent palæontologists can at last be used

with certainty as a means of determining the true nature of an apparently monocyclic crinoid. Neither space nor the subject in hand permit the application of it on the present occasion to all doubtful cases. I may, however, state that it leads me to regard *Rhizocrinus* as pseudomonocyclic, a conclusion to which Wachsmuth and Springer have come on other grounds (p. 63). On the other hand, they consider *Bathycrinus* and *Hyocrinus* as "true monocyclic forms." Direct evidence is entirely wanting in the case of *Hyocrinus*; but as for *Bathycrinus*, the figures of the nerve-cords published by P. H. Carpenter and D. C. Danielssen[1] lead me to place it among the Dicyclica Inadunata.

Hitherto scant attention has been paid by neontologists to the orientation of the axial cords of the stem, and of the chambered organ, and to the intimate structure of the capsule of the latter. For example, the magnificently detailed and elaborately illustrated account of *Calamocrinus* by that skilled anatomist of Echinoderma, Mr. Alexander Agassiz, throws no light whatever on this essential point. Perhaps it is not too late to hope that he may yet be able to elucidate it from his material. If those provided with the modern means of microscopic research and with opportunity to use them have their attention turned to this inquiry by the present review of Wachsmuth and Springer's important researches, it will have been written to good purpose.

Both basals and infrabasals are primitively five in number. But the basals of monocyclic, and the infrabasals of dicyclic, crinoids may become changed in number and shape by fusion and growth. These changes and their relations to the anal plates of the cup are fully discussed in the Monograph. There are also several statements as to the position assumed by the smaller basal or infrabasal in those cases where the base consists of one small and two large plates. This latter is a point on which much stress has been laid, but I believe its importance is exaggerated. It is, for instance, stated by Wachsmuth and Springer that "in all Crinoids with an unequally tripartite, monocyclic base, the smaller plate is located to the *left* of the anterior radial." This is not correct. In *Storthingocrinus* the small basal is the left posterior, as may be gathered from the figures of Schultze[2] on pl. x (not on p. 69, which is wrong), and from the recent description by D. and P. Oehlert,[3] who discuss this question under somewhat mistaken notions. In the "Crinoidea of Gotland" specimens of *Gissocrinus* were described with the small infrabasal in the left posterior and right anterior radii; but Wachsmuth and Springer have always found it in the anterior radius in allied genera. It is hardly correct to state that "the anal plate of 'Dicyclica' rests invariably upon the truncated upper face of the posterior basal" (p. 59).

[1] "Norske Nordhav's Expedition: Crinoida."

[2] "Echinodermen des Eifler Kalkes": *Denkschr. Akad. Wiss. Wien*, xxvi, pp. 113–230, pls. i–xii; 1867.

[3] "Foss. Devon. de Sta. Lucia": *Bull. Soc. Geol. France*, xxiv, pp. 814–875, pls. xxvi–xxviii; 1897.

I believe the following to be a true summary of the facts concerning the structure of the base :—

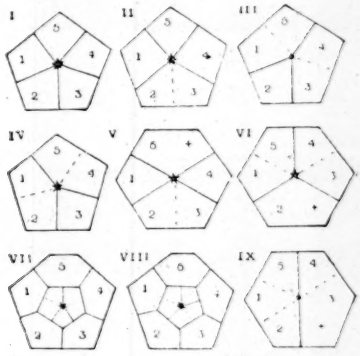


FIG. 4.—Bases and their modifications.

i–vi and ix, monocyclic ; vii and viii, dicyclic.
i–iv, pentagonal, unaffected by anal.
v, vi, ix, hexagonal, affected by anal.
In all the anal side is uppermost ; the imaginary additional piece is marked +.
i, 5 BB ; ii, 4 BB ; iii, 3 BB, Crinoid type ;
iv, 3 BB, Blastoid type ; v, 4 BB ; vi, 3 BB ;
vii, 3 IBB, as usual in Dicyclica Inadunata ;
viii, 3 IBB, as usual in Flexibilia Impinnata ;
ix, 2 BB.

The first stage is the fusion of one pair, producing one large and three small plates (Fig. 4, ii). This is almost entirely restricted to Monocyclic genera, where the plates that fuse are r. and l. ant. BB. Next comes the fusion of two pair, producing one small and two large plates (Fig. 4, iii). This occurs in both Monocyclica and Dicyclica. In the former the small plate is l. ant. B, or rarely l. post. B, whereas in Eublastoidea it is r. ant. B (Fig. 4, iv). In Dicyclica 3 IBB have been observed only among Inadunata and Flexibilia; in the former group the small plate is often, but not always, ant. IB (Fig. 4, vii) ; in the Palæozoic representatives of the latter it is (*apud* W. & Sp.) always r. post. IB (Fig. 4, viii), but this is not the case in *Antedon*. A bipartite base is formed only in a few Monocyclica; the two plates lie on the r. and l. sides of the sup. (Fig. 4, ix). Finally, all plates of the proximal circlet may fuse into a solid ring, both in Monocyclica and Dicyclica. IBB may fuse with the proximal columnal in Flexibilia, thus forming a pseudomonocyclic type. BB may be overgrown by and incorporated with the RR, as in *Eugeniacrinus*.

The symmetry of the base is modified by the presence of anals. An anal resting on the basal circlet causes one of the BB to double in width, so that the base becomes hexagonal instead of pentagonal. Thus the quadripartite base comes to consist of a post. and ant. large plate, and two small lateral plates (Fig. 4, v). These tend to approximate in size. In *Xenocrinus* interbrachials as well as anals come down between RR, so that the BB are nearly equal in size,

but irregular in shape, and make the base decagonal. Removal of anals and Br from the radial circlet leaves a pentagonal quadripartite base, such as is found in Melocrinidæ. An anal resting on a tripartite base is accompanied by increased width in the small l. ant. B (Fig. 4, vi). But in the bipartite base the small B fuses with the combined post. and l. post. BB, while the combined right-hand BB increase in width (Fig. 4, ix). In most Dicyclica the IBB do not assume a hexagonal outline; for the anals do not occur in the basal circlet, but *x*, when it occurs within the cup, truncates the upper surface of post. B. Exceptions are *Sagenocrinus*, *Carabocrinus*, and *Thenarocrinus*. F. A. Bather.

(*To be continued.*)

II.—Bollettino della Società Sismologica Italiana. Vols. II and III, 1896 and 1897.

THE Italian Seismological Society appeals to a limited circle of members (there are not more than 53 altogether), but one out of every three is a contributor to the last two volumes. The *Bollettino* for these years not only reaches, but surpasses, the high level attained during the first year of its publication.

The designing and construction of earthquake instruments still claim a large share of the attention of Italian seismologists; but it is a noteworthy feature of the later attempts that their object is rather to improve and perfect old forms than to introduce new and untried apparatus. Several of the papers belonging to this class are of great value. Professor Grablovitz and Professor Riccò describe the instruments at work in the geodynamic observatories of Ischia and Catania respectively. Dr. Agamennone gives a full account of a sensitive electric seismoscope and instructions for its installation and working. Dr. Cancani describes the horizontal pendulums with mechanical registration recently erected at the observatory of Rocca di Papa, and, in illustration, adds the beautiful records given by it of the Indian earthquake of June 12, 1897. Dr. Pacher contributes a detailed study of the Vicentini micro-seismograph at the University of Padua; while Signor Arcidiacono closes the wearisome controversy on the indications of the normal tromometer by applying the simple test which ought to have been made long before the controversy began.

In addition to the splendid series of records of earthquakes observed in Italy (January, 1896, to June, 1897), Dr. Agamennone contributes notes on earthquakes in the Epirus (Jan. 1897), the Persian Gulf (Jan. 10–11, 1897), the Ionian Sea (May 28–29, 1897), etc. Dr. S. A. Papavasiliou continues the catalogue of Greek earthquakes formerly published in the *Bulletins* of the Observatory of Athens; but, whether it be due to the author's retirement from the observatory or to the unfortunate war with Turkey, the number of shocks recorded during the first half of 1897 is far smaller than in the year before. Professor Omori investigates the decline in frequency of the after-shocks of the great Japanese earthquake of 1854; in another paper he shows that the mean direction of fall of 245 chimneys, etc., in Tokio during the earthquake of June 20,

1894, agrees almost exactly with the direction of the principal vibration at the same place; and, in a third, he estimates that at Gifu and other places in the Mino-Owari plain the movement of the ground during the earthquake of 1891 was not less than one foot.

The study of the pulsations from distant earthquakes is as fascinating to seismologists in Italy as it is to those in other countries. Professor Grablovitz makes a good suggestion for the organized investigation of earthquake pulsations: he proposes that a series of stations should be established near the great circles which approximate most closely to the main lines of volcanic action. Dr. Agamennone calculates the mean velocity of the earth-waves produced by the earthquake of Paramythia (Epirus) of May 13–14, 1895, and the earthquake of Amed (Asia Minor) of April 16, 1896; but in both cases he is hampered by uncertain initial data. Dr. Cancani estimates that the waves from the Indian earthquake of June 12, 1897, as they crossed Italy, were about 30 miles in length and 22 inches in height.

Among the miscellaneous papers may be mentioned two of considerable interest by the last-named author. Pheasants and other birds, it is known, feel the preliminary tremors of an earthquake before man, but Dr. Cancani believes that this is only the case at a distance from the epicentre, and he therefore infers (though the conclusion seems to me doubtful) that these tremors travel more rapidly than the main earthquake-vibrations. In the second paper he collects and discusses a number of observations on the so-called *marina* observed in the inland province of Umbria, and shows that they are identical with the *barisàl-guns* of India and the *mist-poeffers* of the North Sea coast.

The active volcanoes of Italy are the subject of incessant observation by a small, but careful, band of workers. Professor Mercalli, upon whom the mantle of Dr. Johnston-Lavis has fallen, devotes himself especially to the study of Vesuvius, and describes the phenomena observed from July, 1895, to December, 1896. Professor A. Riccò, the Director of the Observatory of Catania, communicates a few notes, chiefly relating to the central crater of Etna, while his assistant, Signor Arcidiacono, summarizes the principal eruptive phenomena of Sicily and the adjoining islands during the years 1896 and 1897. C. Davison.

CORRESPONDENCE.

THE SUBMERGED PLATFORM OF WESTERN EUROPE.

Sir,—Prof. Hull is right in thinking that there is still much to be learned from a careful study of hydrographic charts. The existence of the submarine platform west of our Islands and of the great declivity which he calls an escarpment was of course well known, but the details of the submerged surface certainly merit more attention than they have received, and I do not think their interest is even yet exhausted.

But when Prof. Hull passes from observation to theory he makes several assumptions which are open to question. He calls the great

declivity "an escarpment," comparing it with true escarpments in England and France, and with the cliff-borders of the Nile valley (which are not technically escarpments). He says "all these escarpments have been formed over the surface of emergent lands," that they are absolutely terrestrial, and "that in ascribing a similar origin to those here under consideration we are only drawing a logical deduction from the premises laid down."

The logic of this does not seem very clear. Can Prof. Hull point to a true escarpment anywhere in Europe which has a length of 700 miles and a height above its base of 7,000 to 8,000 feet? Moreover, this so-called escarpment does not stop in the Bay of Biscay: it is continued round the coasts of Spain, it crosses the mouth of the Mediterranean, and runs down the whole length of Africa. It is part of the elevated shelf on which two continents stand, and Prof. Hull may call it an escarpment if he chooses, but it is not comparable with ordinary escarpments, and he is not justified in assuming that it has been formed by atmospheric agencies.

He also tells your readers that "a solid escarpment of this kind indicates a slow continuous elevation *after* the British platform had been planed down by wave action, and subsequent depression after a lapse of time." Here he assumes that the platform was formed first and the escarpment afterwards. I think most writers have supposed that the great declivity which marks the ancient border of the continent is a much older feature than the platform.

Finally, we are told that the formation of the platform "may be referred back with confidence to the Mio-Pliocene period, and that of the grand escarpment to the succeeding early Pleistocene or Glacial stage." There are probably others beside myself who would like to have the reasons for this confident assertion. Is there any reason why the formation of the escarpment and the union of Great Britain with Iceland should not have taken place in the Eocene period? That such a union may have been repeated at a later date is quite possible, but I think the history of the features described by Prof. Hull is much longer and more complicated than he supposes, and I would not like to say that either of them was formed wholly at any one period.

Prof. Hull may have good reasons for his statements, but he does not give them, and as his conclusions are not the only inferences that may be drawn from the facts, they must be discussed before they can be accepted.

A. J. Jukes-Browne.

VERTEBRATE PALÆONTOLOGY.

Sir,—While thanking you for the gratifying review with which my "Outlines of Vertebrate Palæontology" are honoured in the August number of the Geological Magazine, I should like to correct two misapprehensions of the reviewer.

Firstly, it is a mistake to suppose that any "*new terms* are introduced." All the terms employed are to be found in current literature, and most of them are in nearly universal use. Moreover, on its first mention each term which is not likely to be familiar to the elementary student, is not only printed in italics and briefly defined,

but also indexed for ready reference. Under these circumstances the editor and author considered a special glossary to be superfluous.

Secondly, your reviewer is mistaken in describing the lettering of fig. 91, p. 143, as the result of undigested compilation. The interpretation of the squamosal and supratemporal bones in the Squamata there given, is intentional, and based especially upon the researches of my colleague, Mr. Boulenger. Anyone interested in the subject may refer to the figures of the skulls of the Agamoid *Calotes* and the typical Varanoid, *Varanus*, given in his volume on Reptiles and Batrachians contributed to Dr. Blanford's "Fauna of British India." He seems to demonstrate clearly that in Lacertilia the squamosal always retains its normal connection with the post-frontal in front, but eventually separates from the parietal behind; while the supratemporal in that case slips backward to occupy the cleft thus formed.

I am much indebted to your reviewer for pointing out that the legend of fig. 185 (*Palæotherium*) only applies to the true molars, not to the fourth premolar, which, I had omitted to observe, bears the same lettering. In the matter of new illustrations, I have met with unusually liberal treatment at the hands of the publishers; but it was unfortunately impossible to dispense with borrowed electrotypes, and hence the non-uniformity of lettering which is sometimes perplexing.

A. Smith Woodward.

OBITUARY.

JAMES HALL.

Born September 12, 1811. Died August 7, 1898.

By the death of Professor James Hall geology has lost its oldest and one of its most distinguished leaders. He was born at the quaint old town of Hingham on the south shore of Boston Bay, and was educated at the Rensselaer Polytechnic Institute at Troy, and at the age of twenty-five received an appointment on the Geological Survey of New York State. Two years later he issued his first original scientific contribution,—a short note on some trilobites. His official duties were connected with both stratigraphy and palæontology, and at first he was apparently more interested in the former branch of geology. He studied the recession of the Niagara Falls and acted as guide to Lyell, who visited the Falls in 1841. In 1843 Hall was appointed State Palæontologist, in which capacity he wrote or edited no fewer than thirteen large imperial quarto volumes on the Palæontology of New York, which have been issued at intervals between 1847 and 1894. The first volumes of this series formed the most magnificent contribution to extra-European Palæontology that had been issued at that time, and some of the later volumes are still the richest mine of information on some branches of Devonian palæontology. In addition to the extensive series of new fossils described in these monographs, Hall published many further important additions to American Palæontology in the reports of other State Surveys, as of Iowa, Wisconsin, and Missouri, and in papers in various